THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

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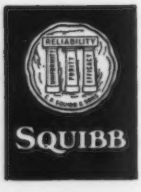

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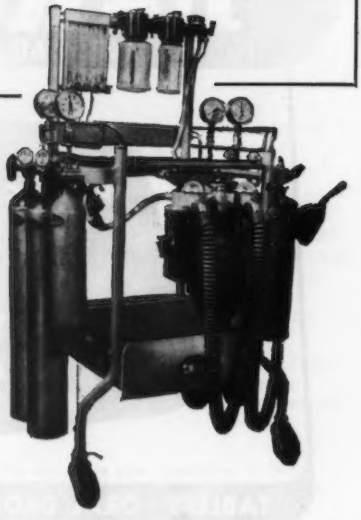

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EDITORIAL

The Address Given by Dr. Wesley Bourne on the Occasion of the Annual Dinner of the Canadian Anaesthetists' Society at Toronto, June 21, 1955

Mr. President, Ladies and Gentlemen:

As honour from one's own associates is the best sort of honour, I most warmly appreciate being called upon to stand before you this evening. Please accept my sincere thanks. It is splendid that we have with us Sir Robert and Lady Macintosh of Oxford who may be assured of hearty welcome to our midst. Sir Robert has done so much to advance the cause of anaesthesia the world about and his missionary work has been so outstanding that we are looking forward very keenly to hearing from him.

I shall now make a few brief remarks concerning the progress of anaesthesia as a specialty.

To begin with, it may be said that, just as Roman education under the Empire used to emulate the god Janus in looking two ways at once, so we of anaesthesia, while preserving and strengthening the more immediate tenets, have been facing the future with the aid of the past, still realizing that our main task is to inculcate how to inherit, appreciatively and critically. Again, with Janus, while cultivating the art of anaesthesia, we have sought and received knowledge at the feet of the learned anchorite of the laboratory—so to overcome the temptation to provide pseudo-rational explanations.

It would seem then, in words like those of Henri Bergson, that, as in personality, anaesthesia, which is being built up each instant with its accumulated experience, changes without ceasing—it shoots, grows, and ripens continuously. Each of its moments is something new added to what was before. As for a conscious being, to exist is to change, to change is to mature, to mature is to go on creating oneself endlessly. Continuity of change, preservation of the past in the present, real duration—the living being seems, then, to share these attributes with consciousness. Can we go on further and say that life, like conscious activity, is invention, is unceasing creation?

There are some of us who can remember the first meeting of the Canadian Society of Anaesthetists thirty-five years ago at Niagara Falls. It was a relatively small affair, but we were honoured by such distinguished visitors as Drs. Guedel and McMechan from the United States of America and Dr. Boyle from London who represented the anaesthetists of Great Britain and Ireland through the Section on Anaesthetics of the Royal Society of Medicine. At that time, Drs. Boyle and McMechan were accompanied by their charming consorts, Mildred and Laurette, respectively. The Jarmans have brought us felicitations from Mildred Boyle and we are delighted to have Laurette McMechan with us now. Great have been the changes since then, and we are happy to have with us, at this meeting, so many more than ever before of the anaesthetists of the Old Country.

Great have been the changes in our knowledge—knowledge of the basic sciences, of drugs, of methods, of combinations of both of these, of preoperative and postoperative care; and we are pleased to be so much more closely associated with our confrères of Great Britain.

But the very best change is that which has come from our efforts to make sure that anaesthesia will go on to become better and better through organized training and through organization of research. Already there are several centres for such activity. While these are evolving, undoubtedly others will come into being. Already the leaders of such a centre are to be congratulated, for they have not hesitated before the magnitude of the task to be accomplished. Already they are recompensed by success, for they have resolved to go to the very end of their effort. Let us say with Molière, "que plus l'obstacle est grand, plus on a de gloire à le surmonter."

There is gratification in seeing teachers surrounded by circles of eager and often emulative youth. Such young people are apt to act as though they did heed Lord Bertrand Russell's words: "Imagination, memory, desire, thought and belief all involve ideas, and ideas are connected with suspended reactions. Ideas, in fact, are parts of causes of actions, which become complete causes when a suitable stimulus is applied." (*Human Knowledge: Its Scope and Limits*, 1948.)

And now, we may be uplifted as we realize that more and more teaching centres are being created and that research in anaesthesia is being extended. At the 1954 Annual Meeting of the British Association for the Advancement of Science held in Oxford, Lord Adrian, Nobelist of Cambridge, said in his presidential address: "If all goes well with our training, the brains we have ought to be more civilised than those of our fathers and those of the next generation more civilised than ours."

We may well be encouraged in the knowledge that advance in our specialty helps to extend the arm of surgery in humane rescue, and, when we ponder our moral obligations, let us re-dedicate ourselves and with Wordsworth say:

> O Duty! . . .
> Give unto me, made lowly wise,
> The spirit of self-sacrifice;
> The confidence of reason give;
> And in the light of truth thy bondman let me live!
>
> *Ode to Duty*

EDITORIAL

Allocution du Dr. Wesley Bourne à l'occasion du Diner Annuel de la Société Canadienne d'Anesthésie à Toronto le 21 juin 1955

M. le Président, Mesdames, Messieurs:

Un honneur reçu de ses associés est le meilleur que l'on peut recevoir et c'est pourquoi je suis profondément touché d'avoir été appelé à prendre la parole ici,

ce soir. Je vous prie d'accepter mes sincères remerciements. C'est un grand plaisir pour nous d'avoir Sir Robert et Lady Macintosh d'Oxford en notre compagnie. Ils peuvent être assurés du plus chaleureux accueil parmi nous. Sir Robert a fait tellement pour faire progresser l'anesthésie à travers le monde et son œuvre a été si remarquable que nous sommes vivement intéressés à ce qu'il nous dira.

Je veux maintenant fair quelques brefs commentaires au sujet du progrès de l'anesthésie comme spécialité.

Pour débuter, on peut dire que comme l'éducation romaine sous l'Empire, qui, suivant l'exemple du dieu Janus, regardait deux cotés en même temps, ainsi nous, anesthésistes, alors que nous préservions et renforcicions les principes les plus immédiats, avons envisagé le futur nous servait du passé réalisant que notre tâche principale est d'inculquer un espirit critique mais aussi appréciatif des faits. De même, comme Janus, tout en cultivant l'art de l'anesthésie nous avons recherché et trouvé la science auprès de l'homme de laboratoire repoussant ainsi la tentation de préparer des explications pseudo-rationelles.

Il semble être, pour prendre les mots d'Henri Bergson que, comme la personnalité, l'anesthésie qui progresse à chaque instant avec son expérience accumulée, change sans cesse, s'avance, grandit et s'epanouit continuellement. Chacune de ces poussées est quelque chose de neuf qui s'ajoute à ce qui était auparavant. Comme pour l'être conscient, pour qui exister est changer, changer est mûrir, mûrir est se créer soi-même continuellement. Continuité sans le changement, préservation du passé dans le présent, durée réelle, l'être vivant semble alors partager ces attributs avec la conscience. Peut-on aller plus loin et dire que la vie comme l'activité consciente est invention et création continue?

Il y en a parmi vous que se rappellent la première reunion de la Société Canadienne d'Anesthésie il y a trente cinq ans aux Chutes Niagara. Ce fut une modeste affaire, cependant nous fûmes honorés par la présence de visiteurs aussi distingués que les docteurs Guedel et McMechan des Etats-Unis et aussi le docteur Boyle de Londres qui représentait les anesthésistes de Grande Bretagne et d'Irlande par l'entremise de la Société Royale de Médecine. A cette occasion, les docteurs Boyle et McMechan étaient accompagnés de leurs charmantes épouses, Mildred et Laurette. Les Jarmans nous ont transmis les félicitations de Mildred Boyle et nous sommes très heureux d'avoir Laurette McMechan avec nous ce soir. Les choses ont bien changées depuis et nous sommes heureux d'avoir avec nous, à cette réunion, un groupe plus large que jamais d'anesthésistes d'Angleterre.

Il y a eu aussi de grands changements dans nos connaissances, connaissances des sciences de base, des médicaments, des techniques, de combinaison des deux et aussi de soins pré- et postopératoires. Nous sommes aussi réjouis d'être beaucoup plus intimement associés avec nos confrères de Grande Bretagne.

Cependant le meilleur des changements est que ce qui a résulté de nos efforts pour assurer le progrès de l'anesthésie va se continuer pour devenir encore meilleur au moyen de l'entraînement organisé et la recherche. Déjà il y a plusieurs centres pour une telle activité. Alors qu'ils évoluent, d'autres s'organisent. Il n'est pas trop tôt pour féliciter les chefs de ces centres car ils

n'ont pas hésité devant l'empleur de la tâche à accomplir. Déjà ils ont reçu la récompense du succès parce qu'ils étaient résolus d'aller à la limite de leur effort. Disons donc avec Molière "que plus l'obstacle est grand, plus on a de gloire à le surmonter."

Quand on voit les professeurs entourés d'élèves désireux d'apprendre et si souvent remplis d'émulation on éprouve de la satisfaction. Ces jeunes gens sont aptes à agir comme s'ils avaient entendu Lord Bertrand Russell dire: "L'imagination, la mémoire, le désir, la pensée et la croyance: tous font naître des idées et les idées en fait sont des éléments causatifs d'action qui deviennent causes véritables à l'occasion d'un stimulus adéquat." (*Human Knowledge: Its Scope and Limits*, 1948.)

Et maintenant, nous nous voyons progresser alors que nous réalisons qu'il y a des centres d'enseignement de plus en plus nombreux et que la recherche en Anesthésie se développe.

À la réunion annuelle de 1954 de l'Association Britannique pour l'Avancement de la Science à Oxford, Lord Adrian de Cambridge disait lors de son discours présidentiel, "Si notre entraînement est bon, nos cerveaux devraient être plus civilisés que ceux de nos pères, et ceux de la prochaine génération, plus que les notres."

Nous devons nous sentir encouragés à la pensée que le progrès de notre spécialité aide à étendre le champ de la chirurgie pour le soulagement des humains. Lorsque nous pensons à nos obligations morales, rappelons-nous notre devoir et avec Wordsworth disons—

> O Duty! . . .
> Give unto me, made lowly wise,
> The spirit of self-sacrifice;
> The confidence of reason give;
> And in the light of truth thy bondman let me live!
>
> *Ode to Duty*

Correspondence

Under the heading of CORRESPONDENCE we publish for the first time in this Journal, a letter from an anaesthetist inviting replies from interested readers of this Journal. Such correspondence has had a place in many medical journals, and has proved frequently to be of great value in the exchange of information and opinions which it permits, without the submission of formal papers or discussions. We sincerely hope that our readers will take up the invitation to reply which is contained in Dr. Fairley's letter, and that this new section of the Journal will become a valuable medium for the exchange of information and personal opinions.

THE HISTORY OF ANAESTHESIA IN CANADA*

H. J. SHIELDS, M.B., F.R.C.P.(C), F.F.A.R.C.S. (ENG.)**

WHEN anaesthesia was given to the world, Canada was a young country not yet a nation; Confederation was some twenty years in the future. The population in 1848 numbered scarcely two million, the large majority being located on the eastern seaboard and in Lower and Upper Canada with a few white settlers in the regions west of the Great Lakes. There were no great cities such as exist today; most of the inhabitants, many of French extraction, were busily engaged in clearing the forests to create farm lands or in the fur trade. Canada in those days was a land of hardy pioneers.

In the early years of the colony's history the medical profession was built up mainly from adventurous spirits who reached the new land as ships' surgeons, these remaining chiefly in Lower Canada. Some undoubtedly were ill prepared from a professional standpoint. In Upper Canada, which became a province in 1791, the profession drew its numbers largely from British army surgeons who were stationed in Canada before and during the War of 1812 and remained in the colony after retiring from the services. Some of these were of high professional standing. By the year 1815 there were all told in the province 36 physicians, the majority of these being in York which was to be incorporated as the City of Toronto in 1834. It was not until the year 1843 that physicians could obtain their degrees in their native land. In that year L'École de Médecin et Chirurgie was established in the City of Quebec. In Upper Canada a Medical Board was created by law in 1818 with authority to hold examinations. These were held at York. In the year 1843, Dr. John Rolph founded a Medical School which in 1848 became known as the Toronto School of Medicine and was incorporated as such in 1853. At this period medical journals published in Canada were few in number. The earliest appears to have been the *Quebec Medical Journal* inaugurated in 1826. The first publications in English were the *British American Journal of Medical and Physical Science* and the *Montreal Medical Gazette,* both established in the year 1845 and published in Montreal. British periodicals were of course available to the profession and it is to be hoped that they had a wide circulation in the country. It may be recorded that Wells, Morton and Simpson made their great contribution to mankind at the period when Canadian physicians for the first time could obtain medical education in their own country and have access to medical publications of Canadian origin.

It is possibly surprising, and certainly pleasing to record how soon after the developments abroad, anaesthesia was put into practice in the colony. In the June issue, 1847, of the *British American Journal of Medical and Physical Science,*

*Presented to the Section of Anaesthesia at the conjoint meeting of the British Medical Association and the Canadian Medical Association, Toronto, Ont., June 23, 1955.

**Toronto General Hospital.

Horace Nelson, M.D. (1) of Montreal reported the results of experiments with Ether on animals, his friends, and by self administration. He stated that while he could not attempt to give a perfect explanation of the mode of action of the agent he believed the nerves of sensation to be first affected with those of motion later. A few days following these trials he assisted his father in the removal of a tumour weighing two pounds from the thigh of a woman rendered unconscious with Ether. He also recorded the extraction of teeth from a number of patients in the same manner. He proposed further experimentation on animals with the view of determining the physiological action of Ether by causing death from direct overdosage and examining post-mortem the brain and the nervous system in general. If carried out these investigations have not come to light. This publication appeared within a few months of Morton's demonstration in Boston. Other writers of the time were impressed with the superiority of Ether over Nitrous Oxide so it is apparent that the use of this agent was prevalent.

The honour of the first use of Chloroform in Canada appears to belong to Dr. A. F. Holmes (2), Professor of Theory and Practical Medicine, McGill College. In the *British American Journal of Medical and Physical Science*, February 28, 1848 (his article was dated January 25), the author records what he believed to be the first application of this agent in the province (probably the first in Canada). Obstetrical patients were the recipients; the dosage he employed was small according to later practices. He obtained the drug from Messrs. S. J. Lyman & Co., Montreal. In the various journals of the period other contributors report the use of Chloroform. E. D. Worthington, M.D. (3), Sherbrooke, Quebec, records three administrations in an article dated February 10. In a report from Pictou, Nova Scotia, we learn that a chemist, J. G. D. Fraser by name, made some Chloroform from a formula obtained from a British publication for use in his own wife's confinement. In the volume containing Holmes's report a method of manufacture of Chloroform is outlined; there is also a reprint under the heading "Periscope" of Simpson's famed communication dated at Edinburgh November 22, 1847, entitled "Discovery of a New Anaesthetic Agent More Effective than Sulphuric Ether." In this journal of the same date are to be noticed several reprints from British publications on the various aspects of Ether anaesthesia. It is interesting also to find a report in detail including the proceedings of a coroner's court with comments of medical witnesses, amongst whom was John Snow, on a death from Chloroform in Britain.

From a study of the medical journals of the time the impression is gathered that the introduction of Chloroform into the anaesthetic field created an increasing interest in anaesthesia in general. The volume of the literature in the medical and lay publications with reference to Chloroform was considerably in excess of that occasioned by the introduction of both Nitrous Oxide and Ether. The contributors in general recognized the dangers of Chloroform anaesthesia and though the belief was prevalent that anaesthesia should be effected rapidly, there is evidence of a definite opinion that high concentrations were to be avoided. We may assume in any event that the use of Ether and Chloroform was widely adopted throughout the country at these early dates.

The impetus provided by the introduction of anaesthesia made revolutionary

changes in surgical practices throughout the entire medical world. As the science of surgery developed the need for greater interest and skill in anaesthesia became apparent. Though some years were to pass before new agents and methods appeared, interest in this aspect of medicine was maintained in Canada as elsewhere. Throughout the years following 1847, reports are to be found in various Canadian publications concerned mostly with individual preferences for agents and techniques of administration. In the *Dominion Medical Journal* published at Toronto we find that Dr. A. M. Rosebrugh (4) on November 28, 1868, addressed the Medical Section of the Canadian Institute of that city, the title of his communication being "Chloroform." He described at some length his personal views after seven years' experience as to the method of administration and the mode of action of this agent. It may be noted that the subscription fee for this journal was $2.00 per annum. In a volume of the *Canada Lancet*, dated 1873, Dr. W. S. Coleman (5), assistant surgeon of the Toronto Eye and Ear Infirmary, reports the use of Chloroform on fifty patients during the previous year. In the same journal appears an editorial outlining the advantages of Ether over Chloroform anaesthesia. Several references also are found to spinal anaesthetic practices, generally pointing out the dangers associated therewith. Anaesthesia held a place of secondary importance, no doubt, in the activities of all these communicants. It is reasonable, nevertheless, to accept the premise that here and there as the operating room assumed greater importance in hospital régimes, some physician showing special aptitude in the subject became known as an anaesthetist. This interest probably would be a part-time occupation with him at first. From such beginnings however the specialty of anaesthesia emerged. Until large hospitals came into being and the surgeon widened his fields of endeavour there could be no full-time anaesthesia. The names of some of these physicians are recorded; the contribution provided by their activities should not be forgotten in a history of this nature.

Coming to more recent times the picture becomes clearer. In all sections of the country certain figures emerge as pioneers in the development of anaesthesia as a definite science and specialty. In Nova Scotia, Muir at Halifax; LaRocque at Hôtel-Dieu, Montreal, preparing the way in French-speaking Canada; Howell, Nagle and later Bourne all of Montreal are well remembered by the older generation of anaesthetists still amongst us. Of these Muir and Bourne are still active. In Ontario, Samuel Johnston's is a figure which looms large in the annals of Canadian anaesthesia. Following his internship, completed in 1903, he was given the task of organizing an anaesthetic service at the Toronto General Hospital. In 1907 he was officially appointed Lecturer at the University of Toronto at which time he devoted himself exclusively to the teaching and practice of his specialty. He became affectionately known as the Dean of Canadian Anaesthesia. Prior to his appointment, Stevenson, Scadding, and John Caven had some prominence in the anaesthetic field at Toronto. In Western Canada we find recorded in the minutes of the proceedings of the Winnipeg General Hospital dated 1899 that Dr. Hutton who had been acting anaesthetist to the hospital since 1893 was officially appointed Honorary Anaesthetist, a post which William Webster assumed in 1902 and was to hold with distinction for

many years. In 1905 Webster was appointed Lecturer in Anaesthesia to the Medical Faculty of the University of Manitoba at Winnipeg. In 1907 he became a full-time specialist in his subject. He was one of the first anaesthetists on this continent to engage in experimental research in animals. In 1924 he published a text book *The Science and Art of Anaesthesia* which for many years was the basis of teaching in his area. In British Columbia some time prior to 1912, Dr. J. W. Thompson was appointed anaesthetist to the Vancouver General Hospital, and following him came Bastin and Freeze.

Johnston and Webster were particularly assiduous in the early years in the preparation of scientific papers directed to anaesthetists and the profession in general. These two pioneering spirits were among the first on this continent to organize departments in their respective universities for the teaching of their subject to undergraduate students. Each, realizing the necessity of better anaesthesia and possibly sensing the developments soon to come, built up physician staffs to meet these needs. At other teaching centres their example was soon followed. When, therefore, in the early years of the present century new agents together with improved anaesthetic appliances appeared on the scene and surgical sciences at the same time reached into new fields, Canadian anaesthesia was in a position to accept and exploit these new responsibilities.

By the year 1920, enthusiasm and numbers had reached the point where it was deemed imperative to organize. With Dr. Wesley Bourne the leading spirit, the Canadian Society of Anaesthetists was inaugurated and incorporated with Dr. Samuel Johnston as President, and Bourne as Secretary. To this adventure came the McMechans, Frank and Laurette, regular attendants at our meetings, eager as always to give enthusiastic support to projects anywhere advancing the cause of anaesthesia. Meetings were held annually for a period of seven years at the end of which time the Society disbanded to become the Anaesthetic Section of the Canadian Medical Association. In 1943 the Canadian Anaesthetists' Society was organized and is now a flourishing body with upwards of six hundred members and a creditable journal under the able editorship of Dr. Roderick Gordon of Toronto. Sections of anaesthesia exist in the Canadian Medical and in several of the provincial Associations.

Canada may be proud of the contribution to anaesthesia on the part of workers in the basic sciences and of practising anaesthetists. Dr. Wesley Bourne, though busily engaged in anaesthetic practice, was associated for many years with the Department of Pharmacology, McGill University. He was the author or co-author of a number of original treatises dealing with the effects on body organs and functions of the various anaesthetic agents and allied drugs. The undergraduate student passing through this department received an unusually good grounding in the pharmacological effects of anaesthetic substances. Dr. Bourne also presented many papers related to the clinical aspect of the newer anaesthetics. His many accomplishments brough him numerous honours, the most notable possibly being the first award of the Hickman Medal. His university has seen fit to instal him as Professor Emeritus, an honour not lightly bestowed at McGill. He is the only Canadian ever elected to the office of President of the American Society of Anesthesiologists. He was chosen by the World Health

Organization to further the science of anaesthesia in Europe, a labour from which he has just recently returned. The scientific attainments and the gift of oratory together with a remarkable personality have resulted in his being much sought after in this country and abroad as the principal speaker at functions of various natures. Dr. Bourne has been for many years and still remains an outstanding personality in the anaesthetic world. At Toronto, Professor Velyien Henderson, while Chief of the Department of Pharmacology at the University of Toronto, was keenly interested in problems related to anaesthesia. Over the years he and his co-workers delved into the pharmacological effects particularly of the newer anaesthetic agents, some of which were used for the first time in his own laboratory. The many publications emanating from his department have made his name known throughout the anaesthetic world.

In March, 1923, Dr. W. Easson Brown (6), a member of the anaesthetic staff of the Toronto General Hospital, working part-time in Professor Henderson's laboratory, presented before the Toronto Academy of Medicine his experiments, animal and human, with Ethylene, an agent which he believed he was using for anaesthetic purposes for the first time. He was quite unaware of the more extensive research with this agent being undertaken by Luckhart and his group at Chicago, whose fine paper appeared a short time after Brown's publication. In 1929, Professors Lucas and Henderson (7) introduced Cyclopropane into the anaesthetic field. It was not until 1933 however, that Waters at Madison, Wisconsin, was able to persuade one of the manufacturers of anaesthetic gases to provide him with enough material to institute further clinical trials. Dr. Harold Griffith (8) of Montreal is another Canadian whose name will be recorded in anaesthetic history. His projection of curare into anaesthesia has had more far-reaching effects in anaesthetic practices than possibly any other recent innovation. For many anaesthetists the world over techniques have undergone changes mostly desirable as a direct result of his contribution. Griffith, like his long-time associate, Dr. Bourne, is a tireless worker, whose activities extend in many directions. He, too, has been the recipient of many honours, one of these being chairmanship of the committee which dealt with the formation of the World Federation of Societies of Anesthesiologists. The inaugural meeting of this body is to be held shortly in Holland.

Canadian anaesthetists were impressed at an early date with the virtues of endotracheal administration of anaesthetic agents. At an International Medical Congress held in London in 1913, Professor Meltzer of New York, whose contributions to this subject did much to popularize it, was a principal speaker. His paper evoked much discussion on the part of many prominent anaesthetists from Britain and elsewhere. Amongst these was William Nagle (9) of Montreal, who reported his experiences with three hundred administrations. In 1927, Hargrave (10) of Toronto described a wire-woven silk-covered elastic catheter, one of the early practical wide bore tubes. He stressed the value of a catheter of this nature in operations such as tonsillectomy employing nitrous oxide insufflation alone or supplemented with ether.

Canada has an excellent record in relation to the Medical Services in general in the armed forces at home and abroad in war and peace. The importance of

anaesthesia as part of these services has always been recognized. In World War I, Robson, now of Toronto, was attached as anaesthetist to No. 1 Canadian General Hospital recruited in Montreal, the first large medical unit to go overseas. The writer, then a member of the anaesthetic staff of the Toronto General Hospital, followed shortly after in the same capacity with No. 4 Canadian General Hospital. Both units were designated as training centres for medical personnel, who after varying periods of instruction were attached to hospitals in more forward areas. Robson's department and my own were supplied with the most modern anaesthetic equipment available at that date and each of us was familiar with and employed endotracheal administration methods. In World War II experienced physician anaesthetists were attached to all large hospital units. Training facilities were made available immediately at home to ensure a continuing supply as new hospital groups came into being. A large centre of this nature was set up at Montreal where under the auspices of Bourne and his associates physician personnel were given four months' intensive instruction, both practical and in basic sciences. Similar training was available also at Toronto under the writer's direction. Contributions of merit to anaesthetic problems more or less peculiar to war casualties were contributed by our anaesthetic services overseas, one of the most notable being R. A. Gordon's (11) intravenous use of procaine in the management of burns and for the relief of pain in the transport of the severely wounded. As in World War I overseas training facilities for physician personnel were established under the direction of S. M. Campbell of Toronto and others to fill growing needs as hostilities expanded.

As the fund of medical knowledge increases, the need for larger numbers of specially trained physicians becomes apparent. Our rapidly increasing population necessitates the building of more hospitals, many of which are being located in well-populated outlying districts. A determined effort is being made to supply these institutions with trained staffs. From the postgraduate training centres young physicians and surgeons well equipped in their specialties are gravitating to these smaller cities and towns. Without equally advanced anaesthesia much of their usefulness would be lost. To meet the need the various postgraduate anaesthetic courses are filled to capacity. The McGill three-year Diploma Course has an enrolment of thirty or more. At Toronto, Halifax, Vancouver, Edmonton, and Saskatoon, similar instruction is available, mostly on a two-year course basis. In French-speaking Canada similar facilities exist at the University of Montreal and Laval University at Quebec. Graduates, after four years' training and practice, may be certificated in their specialty after successful completion of the examination sponsored by the Royal College of Physicians and Surgeons of Canada. Fellowship in the College is also available when certain other requirements such as one year's study in a postgraduate medical course are met. While the supply from these sources does not yet meet the demand imposed by the country's developing economy, more and more hospitals are being provided with modern anaesthesia.

We believe that the anaesthetic structure in Canada rests on good foundations. Scattered across the land are a goodly number of anaesthetists, French-speaking

and English-speaking, some with reputations reaching beyond our borders, whose names have not appeared in this history. The Maritime Provinces are represented by such men as Muir, Stoddart, and Lunney. In French-speaking Canada, to mention a few only, are Cousineau, Hudon, and Longtin. At Montreal, Griffith is supported by such well-known figures as Gilbert, Slater, and others in his undergraduate and postgraduate responsibilities. At Toronto, Campbell, who has succeeded the writer as Chief of the Department, has Gordon, Junkin, and a fine group of progressive and energetic confrères. Queen's University and the University of Western Ontario have active departments as has the University of Manitoba at Winnipeg. Leech is prominent in Saskatchewan. A department has been established recently under Wyant at the University of Saskatchewan, Saskatoon. Anaesthesia at the University of Alberta, Edmonton, is under the able direction of E. A. Gain. Vancouver has a large and energetic group with a most enterprising programme for the new medical school at the University of British Columbia, with Graves in charge. There is no place or need in our country for nurse anaesthesia. Canada has been unfortunate in losing several of its most highly qualified anaesthetists to the larger fields to be found south of our border. We are thankful that a number of others have resisted the pressure brought to bear on them from that direction. Those of us who have had the good fortune to be on the scene here during the great developments in the anaesthetic world in the past thirty or forty years, and who have taken some part, perhaps, in the building of the present structure, have no fear for the future of anaesthesia in Canada. We know that it rests in very able hands.

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KETOSIS OF ANAESTHESIA*

A. R. HUNTER, M.D., F.R.F.P.S.G., F.F.A.R.C.S.**

ETHER glycosuria has been known since 1853 (1) and the upset of the blood sugar concentration associated with anaesthesia has been studied in great detail by numerous workers. The ketosis of anaesthesia has however received very little attention indeed from research workers. It was first recognized in 1893 by Becker (2) and was investigated extensively by Caldwell and Cleveland (3) twenty years later. These workers were unable to correlate the severity of postoperative ketonuria with duration of operation, with upset of blood carbon dioxide combining power, nor yet with the development of postoperative vomiting. The preoperative administration of sodium bicarbonate did not prevent ketonuria nor was glucose given before operation any more effective. Schulze (4) in 1924 showed that a ketosis could occur after spinal and local anaesthesia equally as severe as that in cases who had received inhalation anaesthetics, and there the matter has rested, though there have been more recent studies (5) which, with one exception, have added very little to our knowledge of the subject.

Minnitt in 1932 (6) suggested that anaesthetic ketosis was evidence that the patient had been temporarily converted into a diabetic, and he thought that the adrenalin discharged from the adrenal glands completley antagonized the action of the normal anti-diabetic hormone insulin. It has, however, since become apparent that the antagonism between adrenalin and insulin is by no means as complete as was then believed. Also, the preoperative administration of insulin has proved disappointing as a means of preventing both ketosis and postoperative vomiting. Indeed, the results obtained from this measure when I first began to use it in 1940 were so uniformly unsatisfactory that I felt it desirable to re-investigate the whole matter.

METHODS

Since the basic problem under investigation was a disturbance of uncertain duration which proved to have no regularly recurring peak of severity, the determination of the blood concentration of ketone at some arbitrary time did not seem likely to be of value. Instead the 24-hour output of acetone in the urine was measured. This was estimated in 150 cases. The methods of analysis used were as follows. The acetone and aceto-acetic acid in the urine were removed in one portion by distillation and estimated by combination with alkaline hypoiodite as iodoform (7). In 100 cases the resulting figure was used as a measure of the ketosis. In 25 of these cases, the β-hydroxybutyric acid was converted to acetone by refluxing with potassium dichromate. This estimation was, however, exceedingly tedious to perform and after it had been shown that there was a reasonably close correlation between the hydroxybutyric acid output

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and that of acetone and aceto-acetic acid taken together, only the latter was estimated. In the remaining 50 cases, a quantitative estimate of the aceto-acetic acid content of the urine was made by means of the Rothera nitroprusside reaction.

Blood sugars were estimated by the copper-iodate method of Shaffer, Hartmann, and Somogyi (8) and in most instances the results were checked by a simultaneous Folin Wu estimation with a Lovibond colorimeter.

When Quick's (9) test of liver function was performed the excreted hippuric acid was estimated gravimetrically after precipitation with hydrochloric acid. A correction was made for the amount of hippuric acid still retained in solution. It is freely admitted that this is a somewhat inaccurate test (10) but in the circumstances then prevailing no other method of testing liver function was available which did not presuppose a normal carbohydrate metabolism. Further, the thymol turbidity and caphalin flocculation tests, dependent as they are on a normal blood albumin/globulin ratio, could not be used as they would be liable to be upset by the changes in plasma protein content which are part of the regenerative process which occurs after blood loss at operation.

Urinary acid was determined by titration with N/10 NaOH using phenolphthalein as an indicator and the urinary ammonia by formol titration with the same indicator. When the ammonia/urea ratio was required the latter substance was estimated by the hypobromite method with a Doremus ureometer.

Results

The Anaesthetic

The ketone output for the first 24-hour period was investigated in a group of patients subjected to various types of anaesthesia. The results are shown in Table I. It will be apparent that the most severe ketosis appeared in those to whom ether or chloroform were given in quantity. When truly minimal ether was used as a supplement to nitrous oxide and oxygen and after the administration of cyclopropane, the severity of the ketosis was much less. When

TABLE I

Anaesthetic	No. of cases	24-Hour postoperative acetone output	
		Mean (mg.)	Standard deviation (mg.)
Ether	124	54	59
Chloroform	6	81	42
Cyclopropane	15	13	10
N_2O and O_2 with minimal ether	19	11	7
N_2O and O_2 with thiopentone	19	19	22
Spinal (alone)	15	49	60
Supplemented spinal	3	73	(range 51–107)
Local for nasal operation	9	23	24

thiopentone was used either alone or as a supplement to N_2O, ketosis was not so severe. With spinal anaesthesia and with topical cocaine and adrenalin for submucus resection of the nasal septum, the output of acetone was very variable. In some patients, it was negligible. In others it was almost as considerable as in those to whom ether or chloroform had been given.

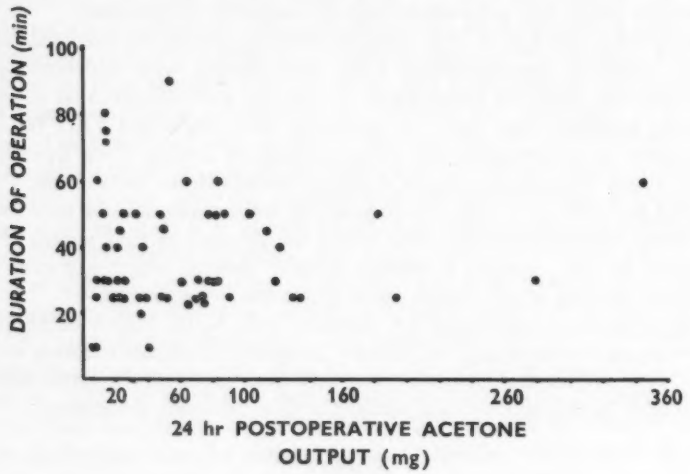

FIGURE 1

Time Factors

The duration of the anaesthetic obviously was of little importance in governing the severity of the ketosis (Fig. 1). Indeed, the correlation coefficient between duration of operation and acetone output was 0.049. Further, when the hourly output of acetone after operation was measured it became apparent that the disturbance was not one which was at its maximum immediately at the end of the anaesthesia and thereafter underwent progressive amelioration. Indeed, the ketone output generally increased for some hours after operation. It recovered a little about 12-16 hours later and then developed a second peak, probably because of the development in some patients of postoperative vomiting. (Fig. 2.)

RELATION TO OTHER METABOLIC UPSETS OF ANAESTHESIA

Acidosis

While it was recognized that the estimation of the plasma CO_2 content and combining power was the most satisfactory method of assessing acidosis at any given moment, it was felt in these cases more appropriate to measure the 24-hour urinary output of acid in order to have some factor to which to relate the acetone output for the same period. To this end, the titrateable acidity of the urine, the ammonia output, and the ammonia/urea ratio were determined in 36 cases where ether anaesthesia had been employed. These results were then examined to see

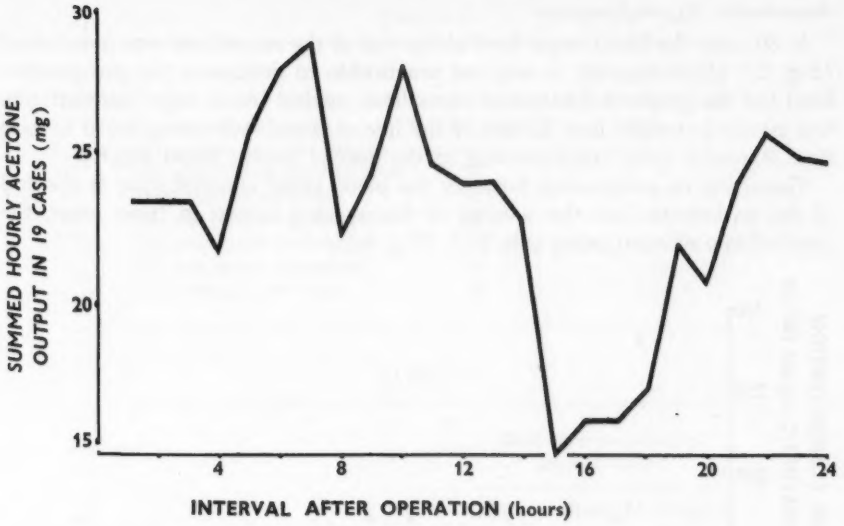

FIGURE 2

whether there was any real association between them and using the correlation coefficient as a measure, no evidence of a parallelism between total acid output, ammonia output, and the ammonia/urea ratio on the one hand, and the degree of ketonuria on the other, could be demonstrated.

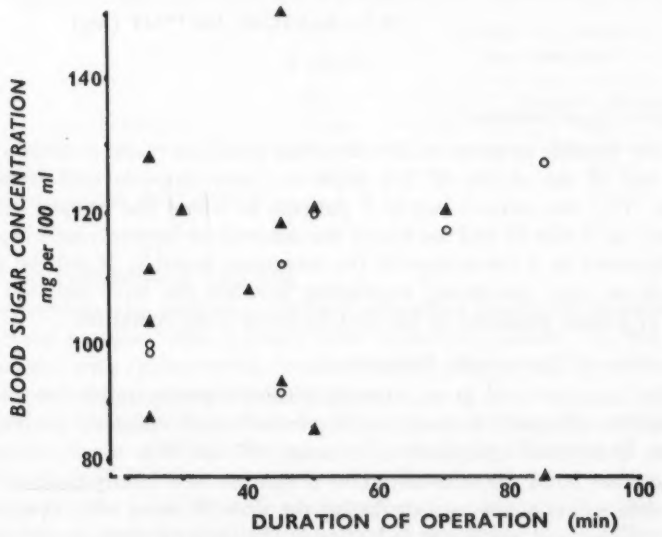

FIGURE 3. O, insulin; △, no insulin

Anaesthetic Hyperglycaemia

In 30 cases the blood sugar level at the end of the anaesthetic was determined (Fig. 3). (Unfortunately it was not practicable to determine the preoperative level but the graph of duration of anaesthesia against blood sugar concentration was nearly a straight line. In fact, if the line obtained was extrapolated to zero time it gave a value corresponding to the normal fasting blood sugar.)

There was no relationship between the blood sugar concentration at the end of the anaesthetic and the severity of the ensuing ketosis in these cases, the correlation coefficient being only 0.11. (Fig. 4.)

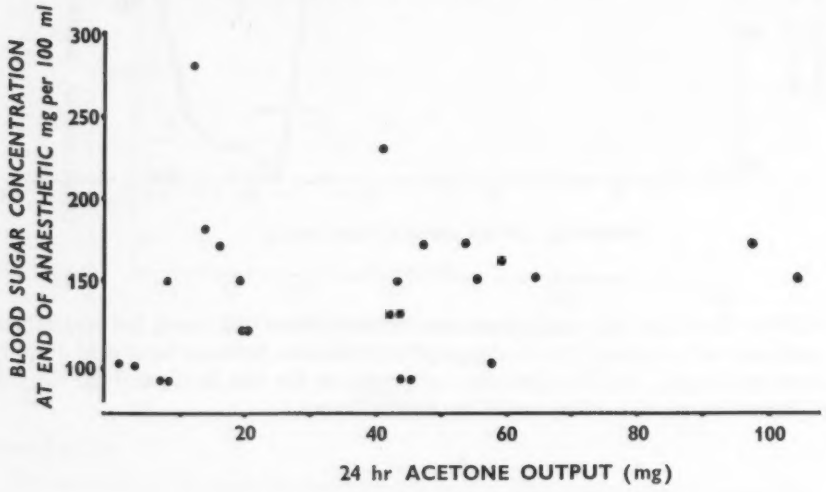

FIGURE 4

Relation to Liver Function

The only feasible measure of liver function available to me in these cases was Quick's test of the ability of this organ to form hippuric acid from sodium benzoate. This was carried out in 6 patients in whom the urinary ketone was estimated. In Table II will be found the amount of hippuric acid excreted by them, expressed as a percentage of the maximum possible. It will be seen that there was no very convincing correlation between the liver function and the amount of ketone produced in the first 24 hours after operation.

Effectiveness of Therapeutic Measures

The first measure used in an attempt to control postoperative ketosis was the administration of insulin in doses varying from 5 to 10 units half an hour before operation. This failed completely in 11 cases (Table III).

On the other hand the administration of glucose in 4 hourly doses of 6 oz. of 10 per cent. solution per rectum during the first 12 hours after operation produced a striking and significant reduction in the severity of the ketosis following anaesthesia (Table IV).

TABLE II

Anaesthetic	Liver function % of maximum	24-Hour urinary acetone output (mg.)
N_2O and O_2 with minimal ether	83	3
Ethyl chloride and ether	81	24
N_2O and O_2 and minimal ether	68	10
N_2O and O_2 and thiopentone	67	4
N_2O and O_2 and chloroform	64	19
Ethyl chloride and ether	58	44

TABLE III

Special treatment	No. of cases	24-Hour postoperative acetone output	
		Mean (mg.)	Standard deviation (mg.)
Nil	124	54	59
Insulin before operation	13	50	36

TABLE IV

Special treatment	No. of cases	24-Hour postoperative acetone output	
		Mean (mg.)	Standard deviation (mg.)
Nil	124	54	59
Rectal glucose after operation	6	15	11

Relation to Postoperative Vomiting

In the patients who were anaesthetized with ether the ketosis was undoubtedly more severe in those who vomited after operation (Table V), but in those anaesthetized with cyclopropane or nitrous oxide oxygen and minimal ether this difference was by no means so striking.

In general, then, postoperative ketosis appeared from this study to be a disturbance whose severity was governed mainly by the type of anaesthetic employed. Its severity was unrelated to the duration of the operation, in sharp contrast to the rise in blood sugar produced by ether anaesthesia which continues progressively at least for the first two hours of the administration. There was no convincing relationship between acidosis and ketosis nor between this latter

TABLE V

	No. of cases	24-Hour postoperative acetone output: Mean (mg.)	24-Hour postoperative acetone output: Standard deviation (mg.)
Patients not sick after operation	33	44	32
Patients sick after operation	24	69	35

upset and the depression of liver function produced by the anaesthetic. Preoperative insulin did not control the ketosis but the rectal administration of glucose after operation largely prevented the upset.

Discussion

For the interpretation of these findings it is necessary to consider the basic physiology of the metabolic processes of the body (11). It has been accepted for many years that ketonuria indicates some upset of carbohydrate metabolism but it was not until recently that it was realized that the essential basis of this phenomenon lies just as much in the processes of fat metabolism. It is now known, partly as a result of studies with radioactive isotopes (12), and partly from other work (13, 14), that ketones are not an endogenous toxin. They are not even the inert products of a disordered metabolism. Aceto-acetic acid is in fact a necessary intermediary in the mobilization of fat when this substance provides energy for the tissues of the body.

Fat consists of glycerol and a fatty acid. The first stage in its destruction is the separation of these. The glycerol is at once swept into one of the enzyme cycles where it is metabolized without difficulty by the tissues. The fatty acid is conveyed to the liver where it is broken down by oxidation, probably at each alternate carbon atom until groups of 2 carbon atom fragments are obtained. These may at once unite with the recently discovered substance coenzyme A and then be directly oxidized to carbon dioxide and water in the liver. Alternatively, again, with the aid of coenzyme A two such 2 carbon atom fragments may unite to form aceto-acetic acid. This latter substance then leaves the liver and is carried in the blood stream to the tissues where it is oxidized once more with the aid of coenzyme A to carbon dioxide and water with the release of the energy (Fig. 5).

The liver is the body's metabolic storehouse. It doles out the materials for tissue metabolism from the glycogen and fat in its cells. It is not, however, selective and it provides only the total amount of material necessary to meet the body's energy requirement. The division of this material between fat, which is discharged into the circulation as aceto-acetic acid, and glycogen, which is broken down to glucose for distribution, is determined only by the availability of these substances in the liver cells. If there is a lot of glycogen there, mainly

glucose will be supplied. If there is virtually no glycogen in the liver, all the body's needs will be met by supplying aceto-acetic acid from fat. Ketonaemia therefore signifies essentially a reduction in the liver glycogen content with an accompanying increase in its fat content. Ketonuria simply means that the level of blood ketones has risen above the renal threshold for these substances which lies like that of glucose only a little above the normal resting blood level.

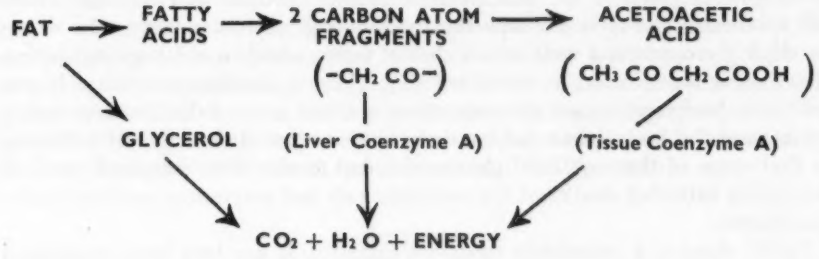

FIGURE 5

The ketosis of anaesthesia thus signifies relative increase in liver fat or relative decrease in liver glycogen. It is therefore necessary to consider what factors go with anaesthesia and operation to tend to bring about such changes. It is conceivable that direct liver poisoning might be responsible but the upset noted had none of the characteristics of a toxaemia induced by the anaesthetic drug. It is true that it was definitely more marked with the "toxic" agents ether and chloroform, but the severity of the upset bore no relation to the length of the anaesthesia. Further, the acme of the disturbance did not appear until after the anaesthetic agent had been withdrawn. This compares sharply with the hyperglycaemia of anaesthesia which becomes progressively worse as the administration of the drug proceeds until all the glycogen in the liver has been mobilized or until the anaesthetic is stopped and then recovers steadily. Also there was no correlation between ketosis and acidosis and this latter change is generally accepted as a true measure of the toxicity of an anaesthetic agent. Lastly, a direct test of liver function failed to indicate any association between ketosis and poisoning of this organ.

The deprivation of food to which the patients were subjected must undoubtedly have played some part in reducing the liver glycogen content. Starvation alone will not, however, account for the conspicious differences in severity of the ketosis produced by different drugs. Further, the ketosis induced by comparable periods of deliberate starvation in experimental studies has not been of the severity noted here (15). Finally, the relative unimportance of starvation is emphasized by the fact that ketosis was almost as severe, when a non-toxic anaesthetic was given, in those who vomited and those who did not.

Another factor which must have been operative in some cases was the hyperadrenalinaemia of fear. Fear, however, was equally likely to mobilize liver glycogen with all types of anaesthesia. It, too, therefore fails to account for the

differences in the severity of the ketosis after the administration of different agents.

The mobilization of liver glycogen to produce hyperglycaemia during the anaesthetic must undoubtedly have played a part in the etiology of the ketosis. But it is difficult to understand the mechanism involved. For there is no apparent reason why some at least of the mobilized glucose should not have returned to the liver whence it was withdrawn. The ketolytic power of the rectal glucose given in the postoperative period indicates that the liver could still synthesize glycogen. Perhaps the mobilized glucose was lost in the urine; for ether glycosuria is a well-known clinical entity which was recognized before blood sugar levels could be estimated (1). There is another possibility. It was shown by Joseph who used the respiratory quotient as an indicator, that during anaesthesia the body burns only carbohydrate to provide energy (16). It may be that some of the mobilized glucose was lost in this way, but final proof of this awaits extended studies of the metabolic rate and respiratory quotient under anaesthesia.

Lastly, there is a completely unknown quantity. It has long been recognized that the lipoid soluble anaesthetics can cause a lipaemia and a transfer of fat from the periphery to the liver, in experimental animals (17, 18). No positive evidence on this matter was provided by the present study, but it is, I think, justifiable to surmise that this factor is the main one in the etiology of anaesthetic ketosis. For it alone will provide an explanation of the differences in severity of ketosis after various types of anaesthesia.

This work was done in the days when ether and chloroform were the mainstays of anaesthesia. I also estimated the acetone output after one modern method and found that the ketosis produced by anaesthesia with ether and chloroform is virtually the same as that which develops when trichlorethylene is used as a supplement to nitrous oxide and oxygen (Table VI).

TABLE VI

	No. of cases	24-Hour postoperative acetone output	
		Mean (mg.)	Standard deviation (mg.)
Ethyl chloride-ether	124	54	59
N_2O and O_2 and trichlorethylene	7	62	67
Chloroform	6	81	42

Clinical Aspects

Before insulin was available it was all too common for a diabetic to go into a coma after an operation. It was, too, generally recognized that this accident was less likely if nitrous oxide and oxygen were used instead of the more toxic agents ether and chloroform. The belief therefore grew up that these agents tended to

aggravate the essential lesion of diabetes—which is a failure of the tissues to burn carbohydrate. This thesis seemed to be supported by Minnitt's (6) investigations. The present study has, however, shown that anaesthetic ketosis merely signifies that the liver's store of glycogen has been depleted without any more serious metabolic upset than a mild inbalance between carbohydrate and fat metabolism. The fact that the administration of a particular agent may give rise to ketosis does not preclude its use in a diabetic as in fact many anaesthetists already know well from practical observation. Indeed, all that is really necessary in the case of the diabetic during the operative period is to ensure that he receives at least his normal amount of insulin, so that his tissue carbohydrate metabolism can continue as usual, together with enough glucose given by a safe and certain route to be sure that his insulin does not cause hypoglycaemia. The period for which such a regimen is maintained must obviously be dictated by the time during which he cannot ingest his normal diet by mouth.

Summary

In summary it was found in a study of the urines of patients after operation that ketosis did not have the features of a toxic phenomenon produced by the anaesthetic. A review of the various physiological factors concerned, however, suggested that this disturbance must indicate a depletion of the liver's stores of glycogen. The factors which might be responsible seemed to be starvation, hyperadrenalinaemia caused by fear, hyperglycaemia due to the anaesthetic itself. This work has, however, tended to indicate that none of these factors will wholly explain the changes observed. It therefore seems probable that the explanation must lie in the increase in the fat content of the liver to which the so-called toxic anaesthetic gives rise. It has been quite clearly shown that the ketosis of anaesthesia is an entity apart from the ketosis of diabetes. An alteration in our outlook on choice of anaesthetic in the diabetic is therefore required.

Résumé

On a découvert en étudiant les urines des opérés que l'acétonémie n'avait pas les caractères d'un phénomène toxique produit par l'anesthésique. Cependant si l'on passe en revue les différents facteurs physiologiques concernés, il semble que ce trouble doit indiquer une déplétion des réserves glycogéniques du foie.

Les facteurs qui pourraient en être responsable semblent être l'inanition, l'augmentation dans le sang des facteurs surrénaux produite par la crainte, l'hyperglycémie causée par l'anesthésique lui-même. Ce travail, cependant, tend à indiquer qu'aucun de ces facteurs explique complètement les changements observés. C'est pourquoi il semble probable que l'explication de ce phénomène doit rester dans l'augmentation des corps gras dans le foie produite par l'anesthésique appelé toxique.

On a demontré définitivement que l'acétonémie de l'anesthésie est une entité différente de celle du diabète. Il faut donc changer notre façon de penser dans le choix d'un agent anesthésique chez le diabétique.

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A METHOD OF ANAESTHESIA AND HYPOTHERMIA IN CEREBRAL VASCULAR SURGERY*

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THE application of hypothermia to cerebral vascular surgery is the result of the physiological observation that a falling temperature, in the absence of shivering, results in a linear decrease in the total body oxygen consumption (1, 2). At 30°C., the oxygen requirement of the body is about 50-60 per cent of normal. Lougheed and Kahn (3) have shown that this holds true for brain. At 25°C., dogs can sustain a period of occlusion of all main cerebral vessels, or breathe 100 per cent cent nitrogen, for a period four times the normal, without irreversible brain tissue changes. On this basis, hypothermia is being used with and without hypotension to lower brain cellular metabolism to a point where occlusion of all circulation to the brain can be carried out for a reasonable period, if required. Reduced brain cell metabolism will tend to relieve arterial spasm and cerebral oedema associated particularly with ruptured berry aneurysms, and will allow complete control over the possibility of gross haemorrhage during the direct approach of an aneurysm, or excision of a large vascular tumour or arterio-venous malformation.

This paper is mainly concerned with the anaesthetic and cooling technique involved, and with some of the problems arising in a series of 31 cases (Table I).

TABLE I

NEUROSURGICAL CASES UNDER HYPOTHERMIA

1. Berry aneurysms	23
2. A-V malformations	5
3. Chordoma	1
4. Glioblastoma	1
5. Hemispherectomy	1
Total	31

The neurosurgical aspects and individual case reports will be reported in detail elsewhere.

METHOD

As there had been previous experience of the potentiation and sedative action of chlorpromazine (Largactil)†† in anaesthesia for general surgery (4), it has been used consistently in the series in combination with promethazine (Phenergan)†† and Demerol (Pethedine). These drugs were used for the purpose of

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sedation, and to reduce the amount of other anaesthetic agents to a minimum, if not replace them. The incidental control of shivering has resulted.

1. *Preoperative preparation.* The diagnosis having been proven by angiography, and the decision to operate made, the patient is assessed by a cardiologist, and the state of the cardiovascular system noted; the investigation includes an E.C.G., E.E.G., and chest X-ray. It is to be noted that the majority of these patients are in the young–middle age group, and usually in good health except for their neurosurgical condition.

2. *Preoperative sedation*

(*a*) If the patient is conscious or semi-conscious, and time permits:
chlorpromazine 50 mgm. promethazine 50 mgm., intramuscularly in the evening.
chlorpromazine 50 mgm. promethazine 50 mgm. demerol 50 mgm., intramuscularly at 6:00 A.M. the day of operation.

(*b*) If the patient is unconscious, the above dosages are omitted.

(*c*) The patient is brought to the theatre at 7:00 A.M., usually in a state of sleep, if he was previously conscious. An intravenous drip of 250 cc. of normal saline is started, containing 50 mgm. each of chlorpromazine, promethazine, and demerol.

3. *Induction of Anaesthesia.* With the above preparation, the patient soon reaches a state of deep sleep. In the first ten cases, anaesthesia was then induced with thiopentone, but this has since been found unnecessary, and contra-indicated, as discussed later. The patient is induced with N_2O/O_2. After a small dose of succinylcholine, the trachea is sprayed with 5 per cent Cyclaine, and intubation carried out, using a large Portex or Magill tube, without packing or cuff.

4. *Anaesthesia.* Anaesthesia is maintained throughout the operation with N_2O/O_2 with or without minimal trichlorethylene using a 10-litre gas flow, non-rebreathing technique. As the temperature falls the trichlorethylene is continued, and the oxygen percentage increased from an initial 30 per cent to 60-70 per cent at the time the aneurysm is being dealt with. This provides a non-explosive anaesthetic with minimal resistance, and thus a slack brain. The patient is allowed to respire voluntarily throughout, even down to 26°C. as occurred in one case.

5. *Cooling.* The technique of surface cooling is used, with ice water. The patient, once anaesthetized, is placed in a stainless steel tank on the standard operating table designed by one of us (W.M.L.) (5). He is not moved from this tank until the operation is completed. The tank construction is such that it allows the head to protrude out on a crutch head rest. During the first phase of the operation when the carotid and vertebral arteries are dissected in the neck and isolated for further use, ice is packed about the legs, thighs, abdomen, and lower chest. This usually requires 30-45 minutes; the table is then placed in a horizontal position and cold water is added to the brim. The ice water is removed at 31-33°C. allowing for a further drift to the desired final temperature of 29-30°.

6. *Recording.* A five-minute interval record of pulse, blood pressure, respirations, and temperature is made. A Cournand needle is inserted by the stab

technique in the left radial artery (if a good ulnar pulse is present), and is connected to a simple aneroid manometer to continuously record the mean blood pressure. This also allows the taking of arterial blood samples for pH and oxygen estimations. The needle is also connected to a citrate-heparin solution, to prevent clotting and thrombosis (the pulse is palpable after the operation). A polyethylene tube is inserted in the jugular bulb for cerebral venous oxygen estimations.

Temperature recordings through a multiple lead thermocouple are made of rectal, thigh muscle, occasionally oesophagus, brain, and bath.

Skull E.E.G. leads are applied, for future use, and two leads of the E.E.G. are used for a continuous E.C.G. writer, and electromyograph (to detect shivering).

A Smith-Stone visual electrocardiography is in continuous use, and frequent multi-lead records are made (Fig. 1).

7. *Shivering.* In the series, shivering has occurred in two cases, and in each instance was controlled by the administration of 25 mgm. of chlorpromazine intravenously.

8. *Induced hypotension.* In five cases, the mean blood pressure was lowered to 30-50 mm. Hg., using Arfonad in four and Hexamethonium bromide in one.

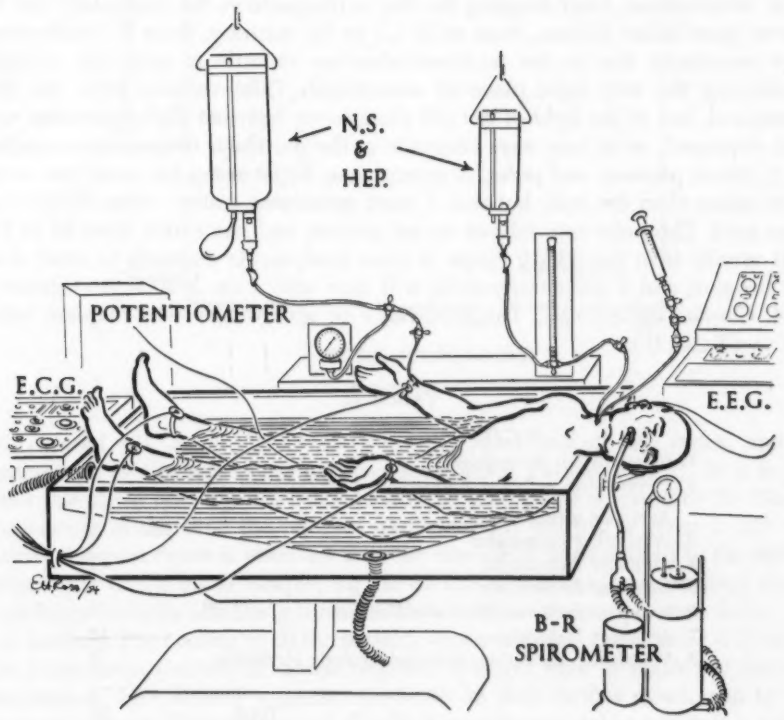

FIGURE 1

9. *Rewarming.* If after the ice water has been removed, the patient's temperature continues to drift rapidly below 28°C., then warm water, up to 33-35°, is added to the tank; otherwise it is left dry until the aneurysm is dealt with. Early in the series, water at 45° was used to rewarm the patient, which invariably resulted in a severe tachycardia and hypotension, and in one case, a moderately severe leg burn. We now add water at a temperature not exceeding 35°C. By the time the operation is finished, the rectal temperature has reached 31-32°, and the patient is removed from the tank, dried off, and allowed to rewarm further, entirely on his own, with only one covering sheet and no blankets. By this method, 6-8 hours elapse before the normal temperature is reached, and hyperthermia has not occurred.

Observations

1. *Method of sedation.* The use of chlorpromazine, promethazine, and demerol in moderate doses, beginning several hours before operation, has provided a satisfactory state of sleep, free of any significant hypotension, but sometimes accompanied by a moderate tachycardia. Induction of anaesthesia, omitting thiopentone, has been smooth, and intubation free of coughing and straining. N_2O/O_2, trichlorethylene anaesthesia, has been adequate; shivering has occurred in two instances and was controlled by 25 mgm. of chlorpromazine.

2. *Respirations.* After stopping the use of thiopentone, the respiratory rate has never been below 15/min., even at 28°C.; on the contrary, there is a tachypnoea, not necessarily due to the trichlorethylene as so little is used, but probably indicating the very light plane of anaesthesia. Tidal volumes have not been measured, but in the light of the pH changes we feel that the respirations were not depressed, or at least were adequate at the particular temperatures reached.

3. *Blood pressure and pulse.* A spontaneous hypotension has been the exception rather than the rule, but was a more prominent feature when thiopentone was used. The pulse rate follows no set pattern, and has varied from 36 to 140, but usually is in the 90-110 range. A sinus bradycardia responds to small doses of atropine, and a sinus tachycardia will slow with 1 cc. 1/2000 prostigmine.

4. *Cardiac arrhythmias.* The occurrence of arrhythmias was frequent below 30°C. (Table II).

TABLE II

E.C.G.—29 Cases Hypothermia

1. Sinus rhythm throughout	9
2. Preoperative auricular fibrillation which persisted	1
Auricular arrhythmias	
3. Wandering pace-maker	2
4. Auricular tachycardia	1
5. Auricular flutter alone	1
6. Auricular flutter and auricular fibrillation	1
7. Auricular fibrillation	12
8. Ventricular fibrillation, preceded by auric fibrillation	2
Total	29

We have the impression that arrhythmias were less frequent, and less significant, after thiopentone was omitted, as this has been the only change in the anaesthetic technique. Many of the arrhythmias were difficult to label with a name, and the electro-cautery caused some interference. Many of the arrhythmias occurred early in the cooling stage, and disappeared at the lower temperatures; others occurred at the lowest temperatures reached and disappeared on rewarming; still others persisted throughout. When arrhythmias did occur, hyperventilation with 100 per cent. oxygen made no appreciable change.

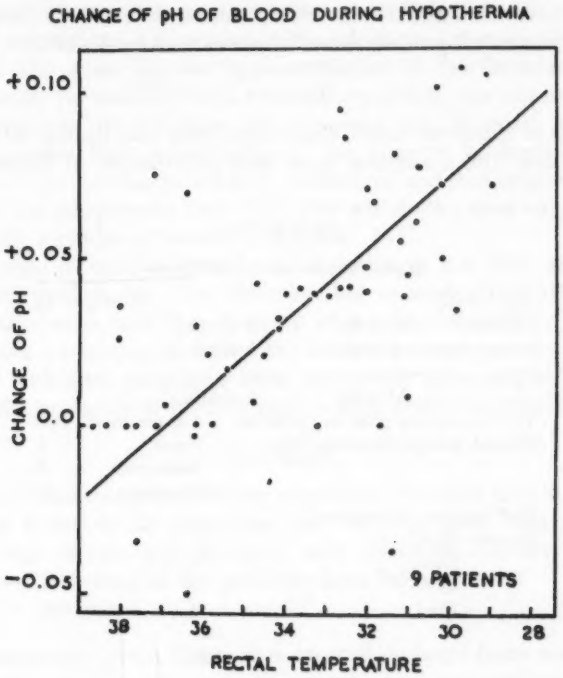

FIGURE 2

5. *Arterial pH Studies* were made in the latter half of the series, and a scattergraph of readings made in nine aneurysms is shown (Fig. 2). It is to be noted that these readings are made on arterial blood, and adjusted to the blood temperature at the time the samples were taken. If the pH is given at 37° an entirely different figure is obtained than the one which is readjusted to the initial temperature of the blood sample, e.g., at 30°C. On this basis, our readings show a tendency towards alkaline pH, rather than acid, as the temperature falls.

6. *Cooling.* The cooling of all the patients was successful, and without difficulty. The large obese patients of course required a longer time to reach the desired temperature, and showed a greater tendency to drift farther down, and to be slower to rewarm. Temperatures of the thigh muscle were taken to act as a guide

as to how far and how fast the drift may be after removal of the ice water, as it represents a cold muscle mass, capable of further cooling the blood. We have not persisted in oesophageal or pharyngeal temperature readings. Cortical and intracerebral temperature readings have always been within 0.2°C. of the rectal temperature. The cooling time varied from 30 to 90 minutes, and the lowest temperature range was from 26.0° to 30.0°C., with an average of 28.6°C.

7. *Recovery time.* After the lesion has been dealt with, the patient breathes oxygen only, and all patients except those who were semi-conscious or unconscious prior to operation moved all four limbs before the last suture was in place. Two patients have been awake and talking coherently at 30°C. Except for some neurosurgical reason, all patients were fully conscious by 33-34°C.

Results

In the series of thirty-one cases, there have been four deaths, all occurring in the 23 aneurysms. The aneurysms have been summarized in Table III.

TABLE III

Berry Aneurysms — 23 Cases

Age: 16–53			*Average*: 42
Ruptured	22 with	3 deaths	
Unruptured	1 with	1 death	
	23 cases	4 deaths	
Time of rupture prior to operation:		4 hours to 47 days	
Clinical preoperative condition:		Coma	1
		Semi-coma	6
		Conscious	16
Clot found at Operation: 7			
Results:	Excellent	13	
	Good	3	
	Bad	3	
	Died	4	(17.4 per cent)
		23	

Of these four deaths, one can be attributed to the hypothermia, i.e. the patient died from irreversible ventricular fibrillation at 28.3°C. The cause of death in the other three cases was brain destruction from a massive preoperative haemorrhage, gross cerebral oedema due to preoperative softening from middle cerebral artery thrombosis, and secondary thrombosis of both anterior cerebral arteries.

The two cases of ventricular fibrillation occurred at 28.6° and 28.3°C respectively: both patients were in their fifties, and both under induced hypotension with Arfonad. Their blood pressures at the time of onset of ventricular fibrillation were 78/55 and 66/35 respectively. One patient made a full recovery after a fifteen-minute interval of complete circulatory arrest (before cardiac massage was begun). The other did not respond to electrical defibrillation. Chemical defibrillation after Swan (6) was unsuccessful in both cases.

All the patients other than those with aneurysms made a full and complete recovery from the operation.

There have been no complications to date from the intra-arterial needle punctures, and there has been no evidence of peripheral nerve damage from surface cooling with ice and water.

Discussion

The technique of anaesthesia and cooling outlined above is adapted to neurosurgery, where the electro-cautery is required, and a slack brain is necessary. For that reason inflammable gases and the use of relaxants and controlled or even assisted respirations are avoided. Although there is considerable argument for controlled and even vigorous hyperventilation in the literature (7, 8), to prevent acidemia, presumably from CO_2 accumulation, our observations, from the above technique, do not bear this argument out. It seems reasonable to suppose that under light anaesthesia in the absence of known respiratory depressants, CO_2 production parallels O_2 utilization, and that respirations at least down to 26°C are adequate to clear CO_2. Our pH studies even suggest a hyperventilation with a tendency towards alkalemia.

The occurrence of cardiac arrhythmias is frequent, but their significance in many cases is questionable. The difficulty lies in recognizing the potentially dangerous arrhythmias, and then deciding what to do: rewarm, or sit tight and watch. We have a tendency to follow the latter course.

The results with aneurysms have been particularly promising as the mortality rate from initial or recurrent haemorrhage is high under conservative treatment.

Summary

A method of anaesthesia and surface cooling as we have used it in 31 neurosurgical cases including 23 aneurysms has been outlined. The neurosurgical details and case reports will be dealt with elsewhere. Observations on the operative course and some of the problems have been given.

Addendum

Since this paper was given, three other cases of ruptured berry aneurysms have been dealt with under hypothermia. All patients made an excellent recovery.

Résumé

L'auteur décrit une méthode d'anesthésie avec hypothermie en chirurgie vasculaire et en rapporte 31 cas. De ceux-ci, 23 étaient des aneurismes cérébraux dont 22 étaient déjà rupturés.

L'anesthésie comporte des injections intra musculaires répetées données avant l'opération, de chlorpromazène (Largactil) de Prométhazine (Phenergan) et de Démérol, suivies de protoxyde d'azote, oxygene et trichlorethylène. Aucun barbiturique est injecté en intra-veineuse et le patient respire par lui-même durant toute l'intervention. Dans 9 cas, on a étudié le pH arterial qui montre une tendance à l'alkalose lorsque le patient refroidit par suite de la méthode anesthésique employée.

L'hypothermie est obtenue par un refroidissement de surface avec eau glacée dans un bain métallique dans lequel on garde le patient durant l'opération. Les moyennes de température obtenues son entre 28°–29°C. La plus basse était 26.1°C.

Il y eut 4 mortalités dans cette série dont une présentant une fibrillation ventriculaire irréversible attribuable à l'hypothermie.

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THE USE OF LARGACTIL IN OBSTETRICS*

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THE ideal agent and technique for managing the problem of obstetrical analgesia has yet to be developed. In 1939 Sturrock (1) laid down these six criteria for the ideal method of relieving pain in labour:

1. That is does not endanger the life of the mother or child, or in any way have an adverse effect upon them.
2. That it abolishes or effectively diminishes pain and the memory of suffering over long periods.
3. That it does not diminish uterine contractions and thereby delay labour or predispose to atonic post-partum haemorrhage.
4. That during the second stage it does not prevent the patient from co-operating intelligently with the doctor, so that an antiseptic and aseptic technique can be maintained.
5. That there is no necessity for operative delivery solely on account of the method used to alleviate pain.
6. That it is simple to give.

These criteria are generally accepted as reliable guides to the assessment of methods of obstetrical analgesia today. No method or agent fulfils all these requirements. The complexity of the problem is appreciated by considering the great number of drugs and diversity of techniques in use, some of which are enthusiastically advocated. It has been pointed out that routine treatment of all obstetrical patients by one method of pain relief is unsatisfactory, if not, in fact, dangerous practice (2). Furthermore, the advisability of complete analgesia and amnesia during labour has been seriously questioned, particularly by psychologists, though Cole (3) has drawn attention to the causation of foetal shock in parturition, an effect which is diminished if the mother is adequately anaesthetized, and the average loss of weight of the baby during the first few days is definitely lessened.

A consideration of the pharmacology of the recently introduced drug Largactil suggested that it might be of value during labour and this paper reports the findings with Largactil used alone, or with other agents, in over 100 patients delivered at the Maternity Pavilion of the Winnipeg General Hospital during 1954. This study was carried out with the invaluable co-operation of the personnel of the Obstetrical Department.

Largactil is also known as 4560 R.P., Chloropromazine hydrochloride, and Thorazine (S.K.F.). It is a Phenothiazine derivative and is related to various Thiazine dyes such as Methylene Blue and drugs such as Phenergan, Avomine, and Diparcol (Fig. 1).

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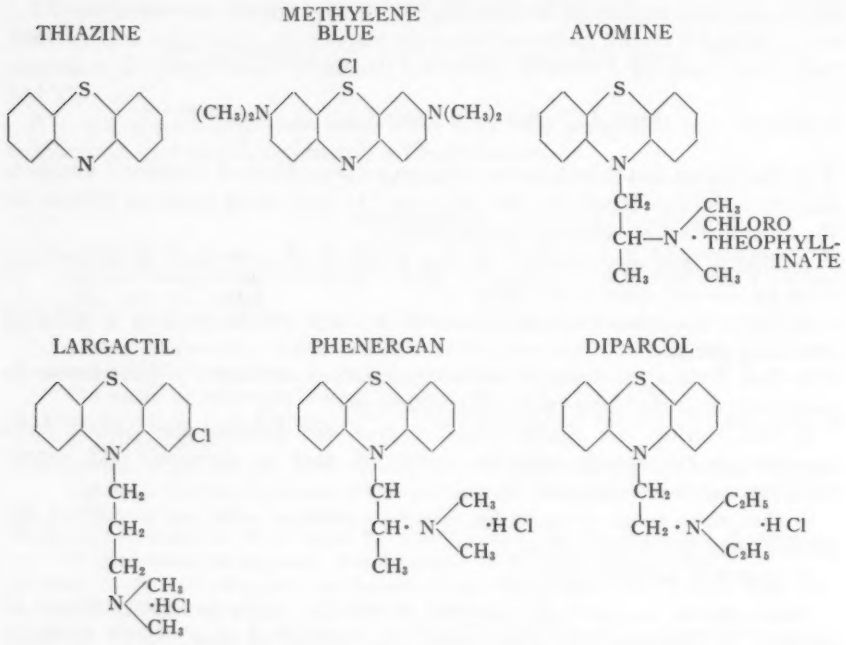

FIGURE 1. Chemical structure of substances closely related to Largactil.

As Largactil contains the C–C–N= linkage, it is an antihistamine according to the competitive inhibition theory (4). It has this linkage in common with many other potent drugs, and this to some extent explains its effects of either potentiating or antagonizing pharmacologically active agents such as local anaesthetics, antihistamines, acetyl choline, and pressor amines, particularly adrenaline.

PHARMACOLOGY

The pharmacological effects of Largactil are very complicated and at present imperfectly understood, as the actions are many and diverse, and often apparently contradictory. However, the more significant and substantiated effects are briefly summarized.

EFFECTS ON THE CENTRAL NERVOUS SYSTEM

In a review of the French work, Hopkin (5) considers the central action of Largactil most important. It is suggested that the effects are best explained by the highly developed central depressant effect on the reticular formations of the brain. The reticular formations are believed to contain centres which control vomiting, heat regulation, autonomic nervous system tone, wakefulness, muscle tone, secretions of the anterior lobe of the pituitary, and vaso-motor tone through mediation of the carotid sinus mechanism. Largactil also suppresses the

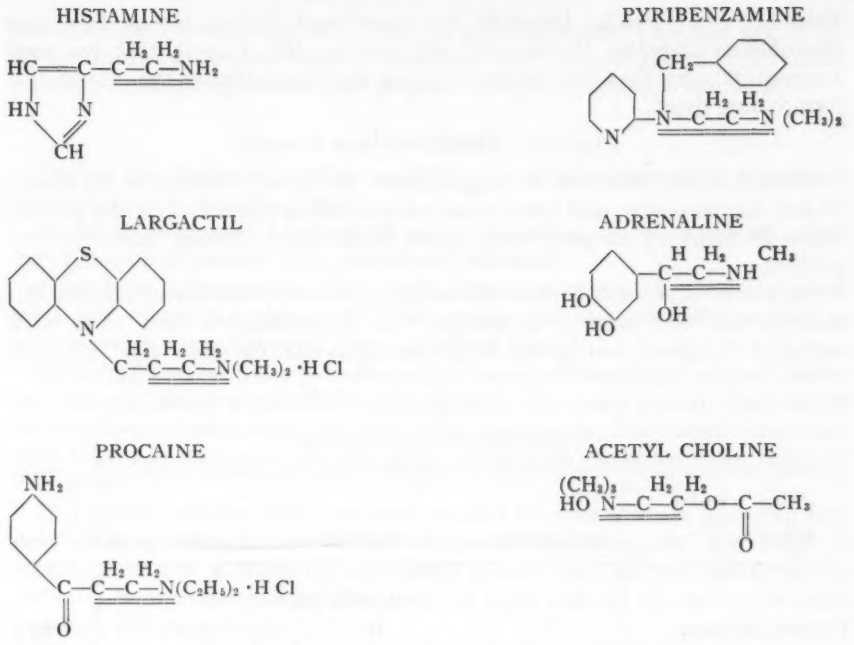

FIGURE 2. Chemical structure of some agents which Largactil may potentiate or antagonize. The -C-C-N= linkage is emphasized.

disturbances activated through the reticular formations as the result of painful, sensory, or nocioceptive stimuli.

The central effects of peripheral sympathetic nervous stimulation are depressed, as also are the effects of endogenous or exogenous adrenaline. Cortical sensory activity is not modified and the E.E.G. shows a pattern similar to natural sleep. The well-recognized effects of potentiation of narcotics, general and local anaesthetics, and some muscle relaxants are probably due to these central depressant effects.

The peripheral effects of Largactil are also of importance and these include a powerful antagonism to adrenaline, and a less marked antagonism to acetyl choline and histamine.

The effects of Largactil on respiration have been well described by Gilbert (6). One would not expect Largactil to be unduly depressing to the respiration of mother or child in the dosage and combinations used in this series.

USE OF LARGACTIL DURING LABOUR

In 1952 Laborit (7) used Largactil and Demerol by slow intravenous infusion to suppress labour pains. Good results were claimed.

A preliminary report on the use in labour of Largactil alone, or with various combinations of drugs, has been published by Hershenson, Isaac, Romney, and

Reid (8). In Canada, Largactil has been used during labour by many anaesthetists including Gordon (9) and Martin (10); Carroll (11) has used Largactil in more than 200 obstetrical cases, and his results are the subject of a forthcoming paper.

Material, Procedure, and Findings

When Largactil was used in surgical cases the great difference in the effects of oral, intramuscular, and intravenous administration was noted. In the present series 25 mgm. of Largactil were given intravenously during labour to 100 patients.

For a control series, 100 cases delivered by the same obstetricians during the same period were selected at random and compared, but toxic cases were excluded. Largactil was given to 20 primigravidae (average age 21.6), 68

TABLE I

Sedation during First Stage

Sedation \ Parity	Primigravidae	Multigravidae	Grandmultiparae	Totals
		A. With Largactil		
Demerol, 100 mgm. Scopolamine, gr. 1/150	7	16	1	24
Demerol, 100 mgm.	3	19	2	24
Demerol, 75 mgm.	1	6	1	8
Nisentil, 40–60 mgm.	2	6	0	8
T.C.E., self-administered	0	4	0	4
Demerol, 25 mgm., I.V.	1	6	0	7
None	6	11	8	25
		B. Without Largactil		
Demerol, 100 mgm. Scopolamine, gr. 1/150	12	16	1	29
Demerol, 100 mgm.	5	33	3	41
Demerol, 75 mgm.	0	7	0	7
Nisentil, 40–60 mgm.	3	2	1	6
T.C.E., self-administered	1	2	0	3
None	2	7	5	14

multigravidae (average age 28.8), and 12 grandmultiparae (average age 37.5). In the control series there were 23 primigravidae (average age 22.1), 67 multigravidae (average age 28.8), and 10 grandmultiparae (average age 39.5).

Management

During the course of labour, analgesics were administered if considered necessary by the attending staff.

As labour progressed Largactil 25 mgm., diluted in 10 cc. of normal saline, was given intravenously when considered indicated.

Apart from patients experiencing early distress in labour, Largactil was given with best effect in primigravidae just before full cervical dilation and in multigravidae when the cervix was about half dilated.

Following Largactil, the patients usually became dramatically relaxed within two minutes, sleeping peacefully between pains but easily roused. They would awaken during uterine contractions or rectal examination. They would co-operate well. Where apprehension was present it was invariably relieved when Largactil was given.

The psychic sedative effect was most marked in eight patients, including four primigravidae, who became almost unmanageable during the first stage of labour. One was a diagnosed psychotic patient and another known to be suffering from hysteria. After Largactil, all eight patients became more calm, peaceful, and co-operative.

It will be seen from Tables II and III that Largactil did not increase the need for operative delivery, as spontaneous delivery occurred 64 times when Largactil had been used, compared with 57 spontaneous deliveries in the control series.

It was often observed that patients who had received Largactil had an unusually relaxed perineum. As a result the incidence of episiotomy was decreased, and it is also seen from Table III that the number of intact perinei was 55 compared with 36 in the control series.

The episiotomies or perineal tears were repaired under local infiltration with 2 per cent Procaine without additional anaesthesia when Largactil had been used, while in the control series general anaesthesia was necessary in addition to the local infiltration in nine cases. In three additional cases in which local infiltration was inadequate for episiotomy repair, Largactil was given instead of general anaesthesia and was satisfactory.

Supplementary anaesthesia was not considered necessary for 32 patients who had received Largactil. Of these, 18 patients had received either Demerol or Demerol and Scopolamine; 4 had been given Demerol 25 mgm. intravenously; thus 10 patients had received Largactil only during the course of their labour.

The use of Largactil greatly reduces the need for supplementary anaesthesia and particularly deep general anaesthesia for operative deliveries. Nitrous Oxide with 30 to 40 per cent Oxygen was adequate for most procedures. Emergence from anaesthesia was not delayed; all patients were returned to the ward as usual and special nursing care was not considered necessary. Following Largactil, administration of general anaesthesia was unusually smooth and stridor when traction was applied to obstetrical forceps was noted in only three patients, in

TABLE II

Average times from administering the sedative drug to giving Largactil and average times from giving Largactil to full cervical dilatation and to the time to delivery

Average Times \ Parity	Primigravidae		Multigravidae		Grandmultiparae	
	Hr.	Min.	Hr.	Min.	Hr.	Min.
Sedation to Largactil	2	35	1	35	1	33
Largactil to full cervical dilatation		36.4		31.2		46.2
Largactil to delivery	1	14		44.2		50.5

TABLE III

Course of Labour in Both Series

	Parity \ Delivery	Spontaneous	Operative delivery				Perineum		
			Outlet forceps	Rotation and forceps	Breech with Piper's	Face	Intact	Episiotomy	Rear
Largactil Used	Primigravidae	7	12*	1	1*	0	5	13	2
	Multigravidae	46	12*	7	4*	0	38	21	9
	Grandmultigravidae	11*	1	0	1*	0	12	0	0
No Largactil (Control)	Primigravidae	6	12	5	0	0	5	17	1
	Multigravidae	44	12	8	2	1	23	37	7
	Grandmultigravidae	7	1	2	0	0	8	2	0

*Including twin deliveries.

TABLE IV

Anaesthetic agents used when supplementary anaesthesia was necessary and also the agents used in the control group

Supplementary anaesthesia	Largactil used	Largactil not used
N_2O–O_2–Cyclo	15	56
N_2O–O_2–T.C.E.	0	21
N_2O–O_2	52	10
Spinal	1	0
T.C.E., self-administered	0	5
None	32	8

spite of the light level of anaesthesia. Perhaps Largactil depresses the sacro-vagal "stretch" reflexes.

Assessment of Sedation

The objective evaluation of pain relief in labour is difficult as criteria are usually a matter of individual opinion. However, in the first stage and during the second stage up to imminent delivery, relief of suffering was considered excellent or good in 87 patients. As Largactil is not a true analgesic it is to be expected that of the 13 patients in whom relief was only moderate, 5 had received less analgesics than usual, while 8 had received only Largactil. Towards the end of the series, if no analgesic had been given and labour was progressing well, Demerol 25 mgm. was given intravenously mixed with the Largactil. Satisfactory sedation was obtained in all such cases.

Subjective evaluation is equally unreliable, but on questioning on the second or third day after delivery, the patients gave the following estimate of pain relief during labour: excellent or good, 83; poor, 4; non-committal, 8; 5 were unreliable because of language difficulties. When this delivery was compared with previous or later deliveries, most patients stated that with Largactil they had an easier time.

Amnesia was unusual except in those patients who had received Scopolamine. It must be remembered when considering these results that supplementary anaesthesia was used in 68 cases.

Duration of Labour

The effect of Largactil on the duration of labour is difficult to assess, as it is notoriously difficult to predict the course of even apparently normal labour. The opinion of highly experienced Labour Floor personnel was that labour was definitely speeded up in 6 of the 8 unmanageable patients, apparently speeded up in 6 multigravidae, and in one grandmultipara.

However, labour seemed to be slowed down in 4 multigravidae and in 5 grandmultiparae. All these patients were having irregular pains and poorly sustained uterine contractions. It would appear unwise to give Largactil to patients who are in no distress, or those in whom uterine contractions are infrequent or poorly sustained. This applies particularly to grandmultiparae who, in any case, have little need for the benefits of Largactil. Largactil was given in one case of primary uterine inertia with no apparent effect on the course of labour.

It will be seen from Table V that the elapsed times for the various stages of labour are comparable except in the case of grandmultiparae, and this tends to support the clinical impressions regarding the effect of Largactil on uterine contractions in grandmultiparae.

Effect of Largactil on the Third Stage of Labour

Routinely ½ cc. of Pitocin was given after the head was delivered and 0.5 mgm. Ergometrine when the placenta and membranes were delivered intact.

The placenta was expelled in 17 cases and expressed in 83 cases receiving Largactil. No manual removal of the placenta was performed, but one patient

TABLE V

DURATION OF THREE STAGES OF LABOUR IN BOTH SERIES

Parity	Largactil used			Control series		
	1st stage	2nd stage	3rd stage	1st stage	2nd stage	3rd stage
	Hr. Min.	Min.	Min.	Hr. Min.	Min.	Min.
Primigravidae	11–58	−53.2	−10.7	10–16	−53.1	−8.2
Multigravidae	6–34	−16.8	− 6.9	8–30	−20.6	−6.0
Grandmultiparae	8–06	−41.2	− 9.4	2–10	−19.1	−2.1

was seen 16 days post partum with uterine bleeding and a small placental remnant was removed under general anaesthesia.

In the control series the placenta was expelled in 19 cases, expressed in 80 cases, and manual removal was necessary in one case.

In the cases receiving Largactil, there was one post-partum haemorrhage estimated at 750 cc. This occurred in a grandmultipara. In the control series there were two haemorrhages estimated at greater than 600 cc.

Haemoglobin estimations were made during antenatal care in 83 patients and averaged 75.2 per cent. Post-partum haemoglobin estimated on the 4th to 5th day in 96 cases showed an average reading of 87.7 per cent. In the control series the average haemoglobin values were 74.6 per cent antenatal and 86.8 per cent post partum.

The duration of the third stage was not significantly different in the two series.

EFFECT ON THE BABY

No change in foetal heart sounds was detected after Largactil. The number of babies born was 103 including three sets of twins.

Seven babies weighed less than 2500 gm. (5 lbs. 5 oz.) and were considered premature. There was one still birth due to hydrops foetalis (diagnosed intra-uterine) and two neonatal deaths. One was a case of impacted shoulders in a baby weighing 10 lbs. 1 oz. and was considered a preventable obstetrical death. The other was in a premature baby weighing 4 lbs. 9 oz. The Apgar rating at birth was 8, but the baby became cyanosed after 6 hours and died on the 4th day. An autopsy showed respiratory hyaline membrane disease. Apart from these, the babies all breathed within one minute and were unusually pink. This may have been the result of placental transmission of the Largactil causing peripheral vasodilatation of the baby.

The average Apgar rating was 8.9 and all but two babies had an Apgar rating greater than 6 after one minute. One, a premature baby of 4 lb. 12 oz., recovered without active resuscitation to an Apgar 8 rating in 3 minutes. The other, the first of undiagnosed twins, had an Apgar rating of 5 while the second had an Apgar 9 rating. Thus placental transmission of Largactil was not the cause of the depression of the first twin.

In the control group, which included 6 premature babies, there were 2 stillborn babies and 3 neo-natal deaths. The average Apgar rating was 8.4 and six babies had an Apgar rating of less than 6 after one minute, four of these requiring resuscitation.

General Effects

There was no maternal mortality in either series. The cardiovascular system seemed to be spared ill effect. Following Largactil peripheral vasodilatation was usually observed and was particularly noticeable in the hand and arm veins. In spite of this no change in blood pressure greater than 10 per cent occurred except in 6 excitable patients, when the blood pressure dropped to within normal limits. Pulse rate increased more than 10 per cent in 23 patients, and this effect was more pronounced if the Largactil had been given quickly.

Nausea and vomiting are often a problem during labour, particularly when general anaesthesia is used. The dangers of aspiration of vomitus during obstetrical anaesthesia are fully appreciated by most obstetricians and anaesthetists, yet reports of such disasters are all too common. The classical paper of Mendelson (12) in 1946 describes the dangers in detail as does a recent paper by Parker (13). Gilliat (14) found inhalation of vomitus the cause of death in 3 out of 55 maternal deaths and stated emphatically that these were deaths "which should not have occurred." Klein (15) in a report of 413 maternal deaths attributed 22 to anaesthesia, and of these 7 were due to aspiration asphyxia. The conclusion was that maternal mortality from anaesthesia had risen in that series from 2 to 9 per cent in a six-year period. As 11 of the 22 deaths were attributed to spinal anaesthesia, this method would not seem to be the answer to this particular problem.

The anti-emetic effects of Largactil are well known and have been used to great benefit in vomiting in many apparently dissimilar conditions (16-18), and in the reduction of post-anaesthetic vomiting by Gordon (19) and later by Caplin and Code Smith (20).

In the series in which Largactil was used, 7 patients suffered from nausea and vomiting during the first stage of labour. In all cases nausea and vomiting stopped soon after Largactil was given and the symptoms did not return. Following supplemental general anaesthesia two patients complained of nausea and one vomited a small amount. No patients complained of nausea or vomiting after leaving the case room.

In the control series, 9 patients vomited during the first stage of labour. Following general anaesthesia, 17 patients complained of nausea and 13 vomited. Later in the ward 10 patients complained of nausea and 6 vomited.

The greatly reduced incidence of nausea and vomiting in the Largactil series is attributed not only to the anti-emetic action of Largactil but also to the very much smaller amounts of general anaesthetic agents required, particularly cyclopropane.

No clinical evidence of liver or kidney damage was seen, and there was no increased incidence of post-partum catheterization.

Post-Partum Condition

The patients who had received Largactil were peaceful, relaxed, and drowsy for about six to ten hours. Complaints of afterpains or from episiotomy wounds were few. Although the patients were sleepy, they were co-operative and voluntary fluid intake was not reduced. Patients of both series received Medinal gr. V or Frosst 292 at the discretion of the ward supervisor. Those patients who had received Largactil were given an average of 1.5 medications in the first twenty-four hours post partum, while the control patients received an average of 3.7 medications.

Other Obstetrical Uses

In Mild Toxaemia

During labour, Largactil was given to an additional 8 patients suffering from mild toxaemia. Three were primigravidae, 4 multigravidae, and 1 a grand multipara. Other sedation was with Demerol and Scopolamine or barbiturates as determined by the obstetrician. The combined sedative effect was excellent. Labour was rapid in all cases resulting in 4 spontaneous and 4 outlet forceps deliveries. Blood pressure was reduced in 7 cases to within normal limits and no complications or ill effects were observed.

Eclampsia

Largactil would seem to be of value in treating eclampsia and pre-eclampsia by potentiating the effect of the usual sedative drugs. However, great caution should be used in combining Largactil with narcotic drugs in the presence of liver damage. Largactil has been used in one such case at the Maternity Pavilion and the results are the basis of a separate report.

Hyperemesis Gravidarum

The value of antihistamines in hyperemesis gravidarum was described by Dougray (21) and the use of Largactil by Rouchy (22). Largactil has been used in close co-operation with the obstetrician in 11 cases of hyperemesis gravidarum when other methods of treatment had met with little success. Largactil 50 mgm. was added to 1,000 cc. of 5 per cent Dextrose and the mixture slowly given intravenously. After 300 to 500 cc. of the mixture had been given, nausea was improved in all cases and when 750 cc. had been given the patients were exhorted to take bland fluid and perhaps toast by mouth. Largactil 25 mgm. was given orally and the intravenous infusion continued until 1,000 cc. had been given. Oral Largactil, 25 mgm. q.d.s., was continued and the patient kept on a daily maintenance dose of 25 to 50 mgm. for at least ten days. This was successful, at least temporarily in all cases. On this dosage most patients complained of an aggravation of the feeling of lassitude which is a frequent accompaniment of early pregnancy. This was effectively relieved by concurrent administration of Dexedrine 5 mgm. in the morning.

Caesarian Sections

Largactil was used in 5 cases of Caesarean section. Four were "repeat sections" and one was a case of placenta praevia.

Largactil 25 mgm. was given intravenously 30 to 45 minutes before the time of operation. Induction and maintenance was with Nitrous Oxide and Oxygen. A continuous succinyl-choline drip was used to provide adequate relaxation when required. Operative conditions were excellent and all babies breathed spontaneously. No ill effects on mother or child were seen.

The postoperative condition of the mothers was good and treatment in a postoperative recovery room was not considered necessary.

Summary and Conclusions

Largactil 25 mgm. was given intravenously to 100 patients during labour and the results compared with the course of labour in 100 similar cases.

Following the administration of Largactil excellent psychic sedation was usually observed. The patients became relaxed immediately, slept between pains, but could be easily roused. Apprehension was relieved.

The best results were obtained when an analgesic was also used during the first stage of labour. Largactil was used to best advantage when given to primigravidae just before full cervical dilatation and to multigravidae when the cervix was about half dilated. If no analgesic had been given the simultaneous administration of Demerol 25 mgm. intravenously with the Largactil produced better sedation.

For the actual delivery, if general anaesthesia was necessary, the amounts necessary were greatly reduced, Nitrous Oxide-Oxygen being sufficient for most operative deliveries.

Post-partum sedation was required less often.

Vomiting during labour was relieved by Largactil and the incidence of nausea and vomiting after general anaesthesia and delivery was significantly decreased.

No ill effects on mother or child were observed.

It would appear that Largactil would be useful in premature deliveries as it does not have any apparent narcotizing effect on the baby, and by its use the amounts of analgesics and anaesthetics can be greatly reduced.

Largactil sometimes appears to have a tendency to slow up labour, particularly in grand multiparae and those patients with poor uterine contractions.

In Caesarean section, Largactil combined with light anaesthesia and a muscle relaxant appears to be effective and safe.

It is suggested that Largactil deserves further investigation of its uses in obstetrics.

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Résumé

Cent patients en travail reçûrent 25 mgm. de Largactil en injection intra veineuse et les résultats obtenus furent comparés à ceux de 100 autres patients présentant la même condition.

Habituellement l'administration du Largactil fut suivie d'une excellente sédation psychique. Les patientes devinrent immédiatement calmes, dormièrent entre les douleurs mais purent être facilement éveillées. L'appréhension disparût. Les meilleurs résultats furent obtenus quand on utilisa aussi un analgésique durant la période initiale du travail. Le Largactil fut employé avec le maximum d'effet quand on l'injecta aux primipares avant dilatation complète du col et chez les multipares, quand le col était a moitié dilaté. Quand aucun analgésique n'avait été donné, l'injection simultanée en intra veineuse, de 25 mgm. de Demerol et du Largactil produisit une meilleure sédation.

Quand il fut nécessaire d'employer l'anesthésie générale au moment de la délivrance, la quantité en fut moindre et le plus souvent le mélange protoxyde d'azote-oxygene fut suffisant.

On n'eut moins besoin de sédation après le travail.

Le Largactil fit disparaître les vomissements durant le travail et diminua grandement l'incidence des nausées et vomissiments après l'anesthésie générale et la délivrance.

Aucun effet noscif sur la mère ou l'enfant fut observé.

Il semble que le Largactil pourrait être employé avec succès dans les accouchements prématurés. Il n'a aucun effet narcotique sur le bébé et son emploie diminue de beaucoup la dose des analgésiques et anesthésiques.

Parfois le Largactil semble avoir une tendance a ralentir le travail, particulièrement chez les grandes multipares ou chez les patients a faibles contractions utérines.

Dans les Césaréennes, le Largactil employé avec une anesthésie peu profonde et une curarisant semble effectif et sur.

L'auteur suggère qu'on étudie davantage les possibilités du Largactil en Obstétrique.

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CHLORPROMAZINE AND PROMETHAZINE IN OBSTETRICS*

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THE alleviation of pain during labour and childbirth can be attained with ease, but what is the price often paid for this relief, and for the very inadequate comfort most maternity patients receive? This price is far greater than many of us realize. It is the cause of a great number of foetal and neonatal deaths, and probably of a much larger number of babies who survive mentally and physically maimed.

Hansen (1) states: "Every cog in the wheel is important in making the newborn a bouncing pink bawling infant, rather than a cyanotic limp infant who some day may be spastic, convulsant or idiotic." The obstetricians have improved their care of the mother to such an extent that she need have little fear for her own safety. Anaesthesiologists offer her many choices of pain relief during delivery. But what has been done to reduce morbidity and mortality during the foetal and neonatal period? Statistics on morbidity are, from their nature, unobtainable, but the children's sections of our mental hospitals offer mute but ample evidence of the trauma occurring during these periods. The literature abounds in figures on neonatal and infant death rates. Bundesen, Potter, Fishbein, Bauer, and Plotzke (2) in their excellent monograph point out that in Chicago, although the mortality rate in infants of one month to one year of age had been reduced from 36.8 in 1925 to 6.3 in 1950, the neonatal rate during the same period had been reduced from 36.1 to only 19.4. These figures are representative of most North American centres where well-qualified obstetrical anaesthesiologists do not share the responsibility of the obstetrical team. Our own experience during the past four and a half years would indicate that where the neonatal death rate rises higher than 12, there is a weak or missing link in the chain of the obstetrical team. I venture to predict that the results will be more gratifying, and the returns more profitable, when we are prepared to spend on this stage of life even a small proportion of the effort and money we now devote to prolong the lives of our aged.

The medical staff of the Vancouver Grace Hospital is well aware of this fact. Based on a careful analysis of the causes of our foetal and neonatal losses, a concentrated effort is in constant progress to reduce them further. We realize that among other factors the routine orthodox sedatives and hypnotics used during labour give inadequate relief to the mother and frequently are hazardous to the baby. It is our conviction that a serious attempt to replace them by more effective and less dangerous preparations is long overdue. A review of the drugs now available led us to conclude that two of the newer Phenothiazine derivatives, namely Chlorpromazine (Largactil) and Promethazine (Phenergan) merited clinical consideration.

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The combination of these drugs has been widely studied in hypothermia, but for our purpose it was considered advisable to assess them separately. Both have a sedative action. They potentiate the hypnosis and analgesia of other drugs, apparently without depressing respiratory activity, and they reduce the necessary amounts of anaesthetic agents. They are among the most effective of the anti-emetics. Laborit (3), Martin (4), Davies (5), and others have reported favourably on the use of intravenous chlorpromazine during labour. They conclude that the drug has no ill effect on the baby. We feel that their methods are not practical in most institutions, and wonder if they are not without danger unless the mother is under constant medical observation. We have found no reports on the use of Promethazine alone.

In our series there was no selection of patients; all were of doctors who supported our efforts to find safer and more effective sedation during labour. Our approach to this study has been a purely clinical one. Our results are based exclusively on the observations and impressions of our obstetricians, our anaesthesiologists, our case room nursing staff, and our patients.

At the time of admission, and throughout their labour, patients were carefully observed and pertinent data were recorded. An attempt was made to evaluate their emotional status. Their blood pressure, pulse rate, progress, and response to sedation, as well as foetal heart rate, were recorded. To avoid a possible state of hypotension the patients were not allowed out of bed within six hours of their last sedation. Early in the study it was found that the response from oral administration of the drugs was too slow to make them of value to the patient in labour. Therefore we report only on their intramuscular use.

Chlorpromazine

When labour was well established a dose of 25 mgm. Chlorpromazine was given by deep intramuscular injection; Demerol 25-50 mgm. was given, when need for analgesia became apparent. Chlorpromazine and Demerol were given thereafter, in the same amounts, at the case-room nurses' discretion. In order to evaluate better the action of this combination, the use of barbiturates and other opiates was discouraged. They were used in only 9 per cent of this series.

Two hundred patients received Chlorpromazine during labour. Of these, 127 (63.5 per cent) were primiparae and 73 (36.5 per cent) were multiparae. Two were mildly and one severely toxic. An average of thirty-one mgm. of Chlorpromazine and 75 of Demerol was given to patients in this series. The largest amount used for one individual was 175 mgm. of Chlorpromazine and 350 of Demerol. This was given to a thirty-six year old primipara during a thirty-hour labour. Sixty-eight per cent were considered calm and relaxed on admission but as labour progressed 12 per cent of these became tense, poorly controlled, and inadequately sedated. In contrast 29 per cent were classified as tense on admission, and of these, 60 per cent soon relaxed and became well controlled on the Chlorpromazine-Demerol therapy. Only one was considered hysterical when first seen. She did not improve during her four and one-quarter hours of labour. She obviously received inadequate sedation, having been given only 50 mgm. of Demerol and 25 of Chlorpromazine.

The analgesia and hypnosis from this combination we found most unpredictable. A few patients, on small doses, slept soundly throughout their labour and could not be aroused. These caused us some concern and prevented us from giving doses of Chlorpromazine larger than 25 mgm. at any one time. Some appeared to have obtained no sedation and no analgesia, but the majority were noted to be sleeping well between contractions, awakening and appreciating their pains as they occurred. Many patients recalled their labour as one long continuous pain and had no memory of sleeping between contractions.

The duration of labour appeared to be prolonged. In primiparae the first stage averaged sixteen hours and the second stage one hour. In multiparae these stages averaged ten hours, and fourteen minutes respectively. Most of those patients who were adequately sedated showed evidence of decreased muscle tone. This limpness caused our case-room nurses some concern, and might partly account for the prolongation of labour.

The patient's pulse and the foetal heart rates were not altered. Blood pressure in the normo-tensive patients was not appreciably affected. Thirty-four per cent showed an average systolic fall of 10 and a diastolic fall of 14 mm. of mercury, whereas 23 per cent averaged a rise of 11 mm. in systolic pressure. The only noteworthy change occurred in a toxic twenty-one old primipara whose pressure had risen from 130/90 to 180/120 in less than twelve hours. Subsequent to receiving 25 mgm. of Chlorpromazine and 50 mgm. of Demerol, she became very drowsy, and her pressure reverted to 120/90 where it remained until she was delivered one hour and three minutes later.

Anaesthesia required for delivery was noticeably reduced. Many, even of those who were considered poorly sedated during labour, were adequately anaesthetized for forceps delivery by Nitrous Oxide and Oxygen in the ratio of three to one. Emesis was infrequent. Even after Ergometrine had been given, very few showed any evidence of nausea, or any inclination to vomit.

Although we were dissatisfied with the quality of relief obtained by the mothers during their labour, we were well pleased with the results in the babies. In this small series of two hundred cases there were no foetal or neonatal deaths. Ninety-two per cent of the babies cried spontaneously within thirty seconds of delivery. They were remarkably pink and their muscle tone was excellent. Seven per cent were mildly depressed, but breathed spontaneously within one minute of birth. Of this 7 per cent, one half were of mothers who had been given additional barbiturates or heroin. The other half had been delivered with difficulty, and the mothers had been given more than the usual amounts of cyclopropane. Only one baby caused us concern. It required ten minutes of maintained respiration, was intubated and a considerable quantity of mucus was aspirated from the pulmonary tree. This baby made an apparently uneventful recovery. The mother had received only 25 mgm. each of Chlorpromazine and Demerol and delivery was spontaneous and easy. No evidence of foetal distress had been detected during her labour, and we were unable to account for the depressed state of this baby.

Promethazine

In this second series, combinations of Promethazine and Demerol were given to 300 patients in labour. When the need for sedation became apparent, these

patients were given, by intramuscular injection, 25 mgm. of Promethazine and 50 of Demerol. If, within one hour, relief was inadequate, nurses were instructed to repeat the sedation, and to increase the Demerol to 100 mgm. if greater analgesia was needed. Further sedation of whichever dose had been effective was permitted at the case-room nurses' discretion. As in the Chlorpromazine series, the use of other sedative drugs was discouraged.

In this series of 300 patients, 135 (45 per cent) were primiparae and 165 (55 per cent) were multiparae. An average of 38½ mgm. of Promethazine and 98 of Demerol was given. Seventy-five per cent were considered calm and were relaxed on admission, but as labour progressed 19 per cent of these became tense and poorly controlled. Of the 25 per cent considered tense on admission, 44 per cent improved and became well relaxed and easily controlled.

The addition of Promethazine to Demerol increased its analgesic action, but most apparent was the marked increase in the relief of emotional stress and apprehension. Most patients became pleasantly sleepy but remained mentally alert. No undue depression or unfavourable side actions were noted. Most multiparae, when questioned, replied that although they were aware of their contractions they were having very little discomfort, and that their labours were less unpleasant than on previous occasions. The response to this combination was no more unpredictable than when Demerol alone was used.

Duration of labour in primiparae was appreciably shortened. The first stage averaged eleven hours and forty-three minutes, the second stage one hour and two minutes. In multiparae the first stage averaged eight hours and fifty-one minutes, and the second stage nineteen minutes.

There was no evidence of reduced muscle tone. The patients' blood pressures, pulses, and the foetal heart rates were not appreciably altered. As in those who had been given Chlorpromazine, less anaesthesia appeared necessary for delivery, and the incidence of vomiting was reduced.

In this series there was one neonatal death. This was in a baby who had been severely asphyxiated by a tight nuchal cord during the second stage. Ninety-five per cent of the babies cried spontaneously within thirty seconds of delivery; 4% per cent were mildly depressed but cried spontaneously within one minute of birth. Only three babies, exclusive of the one who died, required active resuscitation. The first had a marked bilateral atelectasis, the second had been severely asphyxiated during the second stage by two tight loops of nuchal cord. No explanation could be found for the depressed state of the third. All made apparently uneventful recoveries.

We are convinced that Promethazine, as used in this series, shortens labour, affords the mother greater relief than any other drugs we have used, and has no ill effects on the baby.

Conclusions

At the termination of these two series a critical review of our results led us to the following conclusions:

Chlorpromazine and Promethazine, given as described above, to the patient in labour appear to have no ill effect on the baby. Both potentiate the analgesic action of Demerol (Table I), reduce the quantity of anaesthetic agents required for delivery, and lower the incidence of vomiting. The response of the mother

to Chlorpromazine is too unpredictable to make the drug of value for routine sedation during labour. This unpredictable factor might be overcome by giving the drug intravenously in the quantity required to attain the desired sedation.

The response of the mother to Promethazine and Demerol is as predictable as to Demerol alone. This drug shows great promise of reducing the discomforts and the duration of labour without harm to the baby.

TABLE I

POTENTIATION OF THE ANALGESIC ACTION OF DEMEROL BY CHLORPROMAZINE AND PROMETHAZINE

	Number patients	Total Demerol	Demerol/patient
Routine sedation (controls)	435	68,200 mgm.	156.8 mgm.
Chlorpromazine series	200	15,000 mgm.	75. mgm.
Promethazine series	300	29,400 mgm.	98. mgm.

The duration of labour appears to be increased by Chlorpromazine but is shortened appreciably in primiparae by Promethazine (Table II). It is our impression that this reduction in the duration of labour can be attributed to a decrease in endogenous adrenalin resulting from lowering of emotional stress. Adrenalin has been shown to increase the cervical tone in the pregnant patient (6, 7).

TABLE II

AVERAGE DURATION OF LABOUR IN CONTROL, CHLORPROMAZINE-DEMEROL, AND PROMETHAZINE-DEMEROL SERIES

	PRIMIPARAE			MULTIPARAE		
	Number	Stage 1	Stage 2	Number	Stage 1	Stage 2
Controls						
Eastman(8)		16 hr.	1 hr. 45 min.		11 hr.	1 hr.
DeLee and Greenhill(9)		16 hr.	1 hr. 45 min.		12 hr.	15–30 min.
Grace Hospital	130	12 hr. 53 min.	1 hr. 12 min.	150	7 hr. 26 min.	16 min.
Chlorpromazine-Demerol	127	16 hr.	1 hr.	72	10 hr.	14 min.
Promethazine-Demerol	135	11 hr. 43 min.	1 hr. 7 min.	165	8 hr. 55 min.	19 min.

Sufficient data have been made available to confirm the compatability of Chlorpromazine and Promethazine in other aspects of anaesthesia, and as both studies outlined here offer worthwhile consideration for further investigation, it would appear logical to assume that a possible solution to sedation during labour could be found in the judicious use of these drugs, employing a combination of the methods now undergoing investigation.

Summary

Two hundred patients were given Chlorpromazine and Demerol intramuscularly during labour. Hypnosis and analgesia were found to be unpredictable. No appreciable alterations were noted in patient's pulse, blood pressure, or foetal heart rate in the normo-tensive patients. The amount of opiates during labour and of anaesthesia during delivery was lessened. Nausea and vomiting were practically absent, and no ill effects on the babies were noted.

Promethazine was given in the same way to 300 patients in labour. A satisfactory sedative dose was reasonably predictable. Hypnosis and analgesia from Demerol were appreciably potentiated by the drug. The labour rooms were noticeably quieter and the patients less concerned about their labour. As with Chlorpromazine, anaesthesia for delivery was decreased and the incidence of nausea and vomiting became remarkably low. The drug appeared to have no depressing or other undesired effect on the baby. It was our impression that Promethazine and Demerol given during labour offer the mother more effective sedation and her baby less harm, than any combination of drugs with which we are acquainted.

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Résumé

Deux cents patients reçurent durant leur travail, du Chlorpromazine et du Démérol en intra-musculaire. Il fut possible de prévoir l'hypnose et l'analgésie. Chez celles à tension artérielle normale on ne nota pas de changement appréciable du pouls et de la tension de même que des pulsations cardiaques foetales. On a pu restreindre l'emploie des opiacés au cours du travail et de l'anesthésie au moment de la délivrance. Il n'y eut pratiquement pas de nausées et vomissements et aucun effet nocif put être noté chez les nouveaux-nés. Dans les mêmes circonstances, chez trois cents patients en travail, on donna du Promethazine. It fut possible de prédire de façon raisonable une dose sédative satisfaisante.

Les effets hypnotiques et analgésiques du Démérol furent augmentés de façon appréciable. Les salles d'accouchement devinrent plus tranquilles et les patients moins effrayées du travail. Comme avec le Chlorpromazine, l'anesthésie pour la délivrance put être réduite et l'incidence des nausées et vomissements devint très basse.

Le médicament ne semble pas avoir d'effets depressifs ou indésirés sur le bébé. L'impression des auteurs fut que le Promethazine et le Démérol donnés durant le travail offrent à la mère une sédation plus effective et à son bébé, moins de danger que n'importe laquelle combinaison de medicaments que nous connaissons.

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ANAESTHESIA FOR THE SURGICAL CORRECTION OF CONGENITAL HEART DISEASE

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DURING the past ten years operative procedures for the amelioration and cure of congenital heart defects have become increasingly common and at the same time more complex. This situation has stimulated, and to a large extent been made possible by, an increasing interest on the part of anaesthetists in cardiovascular physiology and pathology. While many anaesthetic techniques using a variety of agents have been devised, only those methods in current use at the Hospital for Sick Children, Toronto, will be presented, together with a few observations regarding the more frequent complications and their treatment. An experience of over 450 cases during the past six years provides the background for this report (1).

Any anaesthetic technique for cardiac cases must meet certain requirements. During operation, the administration of adequate oxygen and particularly the efficient elimination of carbon dioxide are of prime importance. The operative field must be maintained as nearly motionless as possible during the delicate surgical manoeuvres. Reflex activity, both respiratory ("bucking") and cardiovascular (arrhythmias, bradycardia, and arrest), must be depressed. Adequate means for the treatment of complications should be at hand. These include replacement solutions, various drugs, and an electrical defibrillator.

In addition, it is essential that the anaesthetist be familiar with the cardiac pathology of each patient, the type and degree of the deranged physiology, and the contemplated operative procedure. The differential diagnosis, and the possibility of encountering, at operation, previously undetected anomalies necessitating changes in procedure, should be thoroughly understood before commencing the case. All cases posted for operation at this hospital are presented at weekly rounds and discussed by the cardiologist, surgeon, and anaesthetist before the decision to operate is made.

PREOPERATIVE MEDICATION

Patients in failure receive one of the digitalis preparations for several days before operation.

Children rarely require a sedative on the evening before operation, but in the older child a moderate dose of seconal is occasionally employed.

Until recently a combination of a belladonna alkaloid with a naroctic administered intramuscularly 45 minutes before operation was used routinely. Atropine was employed in most cases. While scopolamine has the advantage of inducing a degree of amnesia, it has the disadvantage of increasing vagal tone as a result of its central action. This has resulted in an increase in the frequency of reflex cardiac arrhythmias which have required the intravenous administra-

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tion of atropine for their abolition. Both morphine sulphate, 1 mg./10 lb. and demerol, 8 mg./10 lb. have proven satisfactory. The latter has the advantage of being vagolytic in contrast with morphine which increases vagal tone.

Recently, premedication with a combination of chlorpromazine, promethazine HCl, and demerol has given satisfactory results. Three techniques have been tried. Initially, the intramuscular injection of Laborit and Huguenard's (2) mixture number one (M1) was found to produce marked variations in the degree of sedation (Table I). The intravenous administration of this mixture

TABLE I

MIXTURE NUMBER ONE (M1)

	Chlorpromazine	Promethazine HCl	Demerol
Volumes used	- - - - -	equal - - - - -	
mg/cc of commercially available solution	25	25	50
mg/cc of M1	8.3	8.3	16.7
Dosage used	- - - -	1 cc/25 lb - - - -	

during the hour before operation produced a disturbing degree of tachycardia in a second group of cases. The present routine provides uniform sedation without undesirable side effects. Chlorpromazine and promethazine HCl are both given in doses of 1 mg./3 lb. either orally or intramuscularly (depending on the size of the child) at 6 P.M. on the evening before operation and again at midnight. The dose is repeated at 6 A.M. the morning of operation and is followed by an intramuscular injection of atropine 45 minutes before operation (Table II). A variable degree of sedation is present when the child reaches the

TABLE II

DOSAGE OF ATROPINE SULPHATE

10 lb. and under	gr. 1/400
10–20 lb.	gr. 1/300
20–40 lb.	gr. 1/200
40–80 lb.	gr. 1/150
80 lb. and over	gr. 1/100

operating floor, and this is augmented by giving small fractional doses of M1 intravenously until the point is reached at which the patient can still be roused but immediately falls asleep if not disturbed.

INDUCTION AND MAINTENANCE

Anaesthesia is induced in all cases with sodium pentothal given intravenously. The injection is made quite slowly until about two "sleep doses" of the drug have been administered, and oxygen is given immediately following loss of

consciousness. While a slight fall in blood pressure usually occurs at this time, frank cardiovascular collapse following sodium pentothal has not occurred. Immediately following the barbiturate, an injection of decamethonium, 1 mg./50 lb., plus succinylcholine, 1 mg./3 lb., is given and hyperventilation with oxygen carried on until apnoea supervenes. The trachea and larynx of the older children are then sprayed with cyclaine 5 per cent. Intubation is performed using the largest uncuffed portex tube that can be passed without trauma to the larynx. An endo-oesophageal stethoscope is introduced and placed for optimum auscultation of heart sounds (3). Continuous auscultation of cardiac and respiratory sounds is carried on throughout the operation.

Anaesthesia is maintained by a combination of non-explosive agents. Nitrous oxide and oxygen are administered throughout, the proportions depending on the degree of cyanosis and general debility of the patient. Small amounts of sodium pentothal are occasionally added, but the total dose rarely exceeds 4 mg./lb. When the expected duration of anaesthesia is greater than 1½ hours an additional dose of decamethonium is administered about one hour following induction. The only other agent used is succinylcholine in small doses just sufficient to maintain apnoea. The indication for additional succinylcholine is either the appearance of slight regular contractions of the diaphragm or increased resistance to manual inflation of the chest in spite of a free airway. Hyperventilation by controlled respiration is maintained at a point just short of interfering with the surgical procedure, and is interrupted each time a precise manoeuvre such as incising a vessel, placing a suture, or adjusting a clamp is made.

The present system appears to offer some advantages. Premedication with M1 reduces the amount of anaesthetic agent required, provides a basis for minimal anaesthesia and rapid return of consciousness, and results in a quiet, co-operative patient free from vomiting and requiring little narcotic for the control of postoperative pain. The non-explosive technique permits the use of various electrical apparatuses (electrocardiograph, oximeter, and hypothermia pump) near the head of the table and gas machine. The maintenance of apnoea with succinylcholine provides easy inflation of the contralateral lung with moderate degrees of positive pressure, a completely motionless field during the more exacting parts of the operation, and at the same time a rapid recovery of adequate respiratory exchange before the patient leaves the table.

Complications and Treatment

The commonest serious complication during cardiac surgery is a more or less rapid failure in the force of cardiac contraction. This is shown by a dilating weakly beating heart, diminished peripheral pulse, fall in blood pressure, and muffling of the heart sounds. Pupillary dilatation indicates the presence of cerebral hypoxia. Cardiac failure is usually accompanied by a degree of bradycardia and may be secondary to it. Whether the primary cause is reflex vagal slowing or myocardial asphyxia is of little import since in either case progression to cardiac arrest may occur, and treatment should be directed toward both etiologic factors. Operative manipulation should be suspended, and the lungs

hyperventilated with 100 per cent oxygen. The intravenous administration of calcium chloride frequently improves the force of contraction, and atropine suppresses any vagal component involved. In practice a mixture of these agents has been quite efficacious (Table III). If immediate improvement in the condition

TABLE III

CALCIUM CHLORIDE–ATROPINE SOLUTION

	Amount used	Dose/cc mixture
Calcium chloride	5 cc. of 10% $CaCl_2$ solution	33.3 mg.
Atropine sulph.	Three gr. 1/400 tablets	gr. 1/2000
Distilled water	10 cc.	
Prophylactic dosage	1 cc/20 lb. up to 3 cc., repeated p.r.n.	
Therapeutic dosage	1 cc/10 lb. up to 5 cc., repeated p.r.n.	

does not occur, cardiac massage should be started before complete arrest occurs. The prophylactic administration of calcium chloride and atropine before clamping the pulmonary artery in the Blalock and Potts procedures, and on the slightest evidence of diminished cardiac activity in all cases, appears to have reduced the frequency of this complication.

Cardiac arrest may occur as a sequel to gradual cardiac failure, dislocation of the heart from its normal position, increased vagal reflexes, or to sudden loss of moderate volumes of blood from either pulmonary artery or aorta. Cardiac massage must be started immediately and maintained until the heart is capable of producing a palpable peripheral pulse. In those cases in which massage alone fails to restore the normal beat, an intracordial injection of epinephrine frequently initiates cardiac action. A preliminary intracordial injection of calcium chloride appears to set the stage for the more effective action of this stimulant. Any deficit in blood volume should be rapidly corrected.

Primary ventricular fibrillation is very rare but fibrillation secondary to cardiac arrest is not uncommon. The cause may be either myocardial, hypoxia, stimulation by the massaging hand, or overenthusiasm in the use of epinephrine. Defibrillation using a direct current is almost always effective, the ensuing arrest requiring treatment as outlined above.

Ventricular extrasystole is the commonest arrhythmia encountered without the assistance of the electrocardiograph. When this instrument is used throughout operation, periods of nodal rhythm and wandering of the pacemaker are frequently observed. In most cases arrhythmias appear to arise as a result of mechanical stimulation and respond to cessation of the surgical manipulation, the application of local anaesthetics to the operative field, the intravenous administration of atropine, and hyperventilation of the lungs.

Sudden loss of moderate to large volumes of blood may result from a variety of surgical mishaps. Some type of apparatus for the rapid administration of adequate replacement solutions should be set up for each case. The rapid

administration of large volumes of blood or plasma may in themselves depress cardiac activity as a result of infusing relatively large amounts of potassium ion. The injection of 10 per cent calcium chloride in 1 cc. increments to any rapidly running transfusion prevents this undesirable complication of treatment.

Acute pulmonary oedema may occur in a variety of conditions. Mechanical blocking of the small bronchioles by innumerable small bubbles, rather than the amount of fluid in the tracheobronchial tree, interferes with pulmonary ventilation. Passing the anaesthetic gases through a detergent such as ethanol in the ether chamber reduces the surface tension of these bubbles which disintegrate, leaving a thin bloody fluid which can be readily aspirated. The degree of positive pressure used during the inspiratory phase should be increased.

The sudden onset of deep inspiratory gasps is evidence of hypoxia stimulation of the carotid body chemoreceptors, and not of recovery from relaxants. This grave omen can occur even in the presence of complete relaxation and apnoea resulting from hyperventilation and the use of succinylcholine.

Dilatation of the pupils has already been mentioned as a sign of cerebral hypoxia. The persistence of dilatation despite efficient massage and the presence of a peripheral pulse is almost without exception prognostic of a fatal outcome.

Following ligation of a patent ductus the blood pressure rises sharply and there is a marked decrease in pulse pressure. The latter may be of such magnitude that a peripheral pulse is almost impossible to find, and undue alarm may be experienced by the anaesthetist unless the blood pressure is taken by auscultation.

A second benign situation which may be mistakenly considered serious is the presence of a large pericardial effusion. This may mask the true myocardial action beneath, producing the appearance of very feeble contractions. The presence of an adequate blood pressure and brisk heart sounds are reassuring, and the removal of the pericardial effusion by the surgeon permits constant observation of myocardial activity and cardiac size.

Hypothermic Anaesthesia

The reduction of metabolism and hence oxygen requirement by physical cooling of the body is now being used in both cardiovascular and intracranial surgery. A temperature of about 28°C. is necessary for those procedures in which the entire circulation must be stopped for several minutes. As an adjunct in the surgery of less complicated cases, temperatures of 30 to 33°C. decrease oxygen requirements and provide an increased margin of safety for the patient. Temperatures in this range are now being used routinely for all cyanotic and poor-risk patients.

Infants are cooled by total immersion in a bath of cold tap water, and larger patients by wrapping in a mattress through which a refrigerant solution is circulated.

The routine system of premedication and anaesthesia described above is used. The inclusion of chlorpromazine in the premedication effectively prevents shivering during the cooling process, and the injection of 1 mg./5 lb. of this agent in refractory cases accelerates the rate of cooling. Sodium pentothal is not repeated

following the induction dose, since its rate of elimination is decreased with decreased tissue metabolism.

At temperatures below 28°C. the likelihood of spontaneous ventricular fibrillation increases although it has been suggested by Bigelow (4) that the production of an alkalosis by hyperventilation may prevent this complication even at these temperatures. Electrical defibrillation of the cold heart is much more difficult than defibrillation at normal body temperature. Warming the heart by filling the chest with warm saline may facilitate defibrillation. Intracordial prostigmine 0.05 cc. of the 1:4000 solution per Kg., has been used in one refractory case with subsequent successful electrical defibrillation (5).

Extracorporeal Heart-Lung Preparation

The correction of some intracardiac anomalies requires an open heart for periods of 15 to 20 minutes. In such cases the heart and lungs are completely by-passed by removing blood from the venae cavae, oxygenating it in either a mechanical or a biological lung, and pumping it back into the arch of the aorta. The anaesthetic management of these cases is again fundamentally the same as that for the more routine procedures. In order to maintain the apnoeic state during the by-pass, a small dose of decamethonium is given several minutes before the extracorporeal circuit is turned on.

If there is evidence of increased bronchial circulation to the lungs gentle inflation of the patient's lungs with oxygen during this period may result in further oxygenation of the circulating blood and the removal of some carbon dioxide. The problem of carbon dioxide elimination from the artificial lung should be appreciated and measures taken to reduce the mechanical dead space of the oxygenating system when a biological lung is used.

Summary

A technique of anaesthesia for the correction of congenital heart defects is described. Premedication with chlorpromazine, promethazine HCl, and demerol is followed by induction with sodium pentothal and maintenance of anaesthesia with nitrous oxide, oxygen, and the depolarizing relaxants. A moderate degree of hypothermia is recommended for all cyanotic and debilitated patients. The more common complications are described, and reliance on calcium chloride and atropine in their treatment is emphasized.

Résumé

L'auteur décrit une technique d'anesthésie dans la correction des maladies congénitales du cœur. Comme médication pré-opératoire, on donne du promethazine et du chlorpromazine la veille de l'opération qu'on fait suivre d'un mélange de prométhazine, chlorpromazine et péthidine dans l'heure précédant l'opération. L'induction se fait au Pentothal sodique. On intube après injection de decamethonium et de succinylcholine. L'anésthesie se poursuit au protoxyde d'azote, oxygen et de petites doses intermittentes de succinylcholine. On maintient une hyperventilation tout au long de l'intervention avec respiration controllée durant les manipulations du cœur ou des vaisseaux.

Une hypothermie modérée est recommandée comme adjuvant dans les cas avec cyanose. Des températures aussi basses que 28°C. sont nécessaires quand l'action de pompe du cœur doit être arrêtée pour de courtes périodes.

La circulation doit être maintenue au moyen d'un extracorporéal dans les cas qui demandent un arrêt de la fonction cardiac pour de plus longues périodes.

La complication sérieuse habituelle au cours de la chirurgie est diminution progressive de l'action cardiaque allant parfois jusqu'à l'arrêt. La prophylaxie et le traitement de cette condition, soulignant l'emploie du chlorure de calcium et de l'atropine, est décrite.

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EVALUATION OF METHODS OF RESUSCITATION*

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PATHOLOGICAL conditions which progress to a state involving impairment of respiratory function are so numerous and occur so frequently that knowledge of the appropriate methods of instituting artificial respiration is a necessity.

To apply methods of artificial respiration successfully not only necessitates a long period of serious practical training but also entails knowledge of pertinent physiology. By necessity, the anaesthetist applies almost routinely different methods of artificial respiration and therefore should be well qualified to teach all aspects of resuscitation. Indeed he should consider it his duty to diffuse his knowledge not only to other members of his profession, but also to non-medical groups.

To lower the appalling toll of drowning tragedies during the summer months, all doctors at this time of year should strive not only to teach methods of artificial respiration, but also to take active interest in the organization of rescue groups in their respective communities. Unless the victim is located in the shortest possible time, all attempts at resuscitation will fail.

Since partial or complete respiratory obstruction is often the precursor of cessation of respiratory function, prophylactic measures against this complication, which by themselves can be life-saving, will be considered briefly.

In all comatose or paralysed patients, where the cough reflex is obtunded, maintenance of a clear airway is realized by frequent aspiration of pharyngeal, tracheal, and bronchial secretions. The patient should be placed in the lateral decubitus to establish gravity drainage of secretions and to assist in keeping the tongue forward. An appropriate artificial airway, either oro-pharyngeal, naso-pharyngeal, or endotracheal should be introduced before it is too late. Even mild partial obstruction should never be tolerated. A snoring, comatose patient should always be considered as a partially obstructed patient. In the presence of a severe glottic or laryngeal respiratory obstruction requiring emergency tracheotomy, laryngeal atresia need not result. More ideal conditions can be secured for a low tracheotomy by the preliminary insertion of a fourteen gauge trocar through the crico-thyroid membrane before cessation of spontaneous respiratory activity (1). If necessary, the insufflation of oxygen through such a trocar, as suggested by Reed and associates (2), should maintain life until tracheotomy is performed. All patients in danger of becoming obstructed should have uninterrupted supervision.

Avoidance of delay in treating respiratory arrest must be insisted upon. Usually cardiac arrest occurs within five minutes after interruption of respiratory function (3). It must be realized that these same considerations also apply to drowning victims. They must be rescued without delay so that artificial respiration can be

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instituted within five minutes of the last resurfacing effort, which usually entails a breath of air. In other words cardiac arrest will generally occur after a total uninterrupted submersion period of five minutes' duration. However, we all know of rare incidents where this time limit did not apply, and for this reason efforts at resuscitation must be carried out on all vicitims who have been rescued within a reasonable period of time. The presence or absence of residual cardiac activity cannot be determined by the means at hand on a beach. It must always be assumed that the heart is potentially capable of recovering adequate function. Cardiac massage through a thoracotomy becomes a formidable undertaking outside the hospital and cannot be recommended for general adoption. However, we do insist that indirect cardiac massage over the left hypochondrium is occasionally successful (4) as are other easily performed manoeuvres such as thumping the precordial region and direct needle stimulation of the heart. Attempts at cardiac resuscitation when required should always accompany any emergency methods of artificial respiration.

All persons should be trained to apply emergency methods of resuscitation. There should be no delay in waiting for the doctor or for mechanical devices. At this point we renew our plea for widespread and often repeated training programmes in emergency methods of resuscitation in all our educational institutions.

Emergency methods of artificial respiration immediately available are the manual methods and mouth to mouth breathing requiring no equipment.

In 1951 co-ordinated studies in the different methods of manual artificial respiration were carried out in the following American institutions: University of Illinois (5), University of Pennsylvania (6), Harvard University (7), and Springfield College (8). Gordon, Sadove, and Raymon (9) analysed and integrated the results obtained. They evaluated the methods according to efficiency of ventilation and oxygenation and to the ease of administration.

They recommended for general adoption methods which, in addition to an active expiratory phase, also combined an active inspiratory phase. The University of Illinois group (5) demonstrated on normal anaesthetized and curarized subjects that the double active phase methods yielded a tidal ventilation at least twice as great as that produced by the prone-pressure method. The Holger-Nielsen or "arm-lift back-pressure" method was selected as the most practical.

With regard to resuscitation of the newborn, Whittenberger (10) believes that the active inspiratory manoeuvre of the manual methods in all probability develops insufficient force to start inflation of airless lungs.

Mouth to mouth, and mouth to nose breathing are other emergency methods immediately available for resuscitation. They may be applied either by direct contact with the victim or in certain instances be made more acceptable by the interposition of an anaesthetic mask if available. In newborn infants and children the method is most effective. The victim's lungs are filled with oxygenated dead space air from the operator's non-functional respiratory cavities. This volume of air is pushed down to the alveoli by subsequent portion of alveolar air from the operator which, however, mainly fills the victim's own dead space. In the

absence of mechanical devices, mouth to mouth breathing appears to be the most effective method of resuscitation in the newborn (11).

Mechanical means of resuscitation are used both for emergency purposes and for long-term maintenance of artificial respiration.

The various types of resuscitators are designed to administer air or oxygen, either alone or as a mixture via a mask or endotracheal tube. Pressure breathing apparatus of this type may deliver either intermittent positive pressure or intermittent positive and negative pressure.

The self-contained hand-operated devices usually incorporate a bellows (12). Other hand-operated resuscitators, such as those represented by the bag and mask arrangement and other types incorporating special valves (13), require a source of air or oxygen and thereby are not self-contained, evidently an undesirable disadvantage when this source of compressed air or oxygen is not available. Since the intermittent positive mask-pressure curve delivered by these devices is in the hands of the operator, optimum results are obtained only when used by trained persons (10).

Automatic resuscitators for emergency use are intended to relieve the operator who has initiated resuscitation by manual methods. Too often fatigue and exhaustion resulting from sustained efforts at maintenance of manual artificial respiration lead to discouragement and unwarranted premature abandonment of the victim. Herein lies the advantage of automatic mechanical devices when they are used for protracted periods of resuscitation.

Since automatic resuscitators have preset pressures varying between 15 and 20 mm. of mercury, which cannot be altered, in many instances they will be unable to meet ventilatory requirements introduced by the individual exigencies of lung compliance. Although it is undeniable that these fixed pressure settings are intended to safeguard the patients' lungs, we recommend the incorporation of a bag and mask principle which could be made to by-pass the automatic mechanism when necessary. Whittenberger, Affeldt, and Mead (14) have shown that compliance of the lungs can be temporarily increased by a single overinflation and recommendations for including a means of providing an occasional deep breath have already been made (10). Another reason why the bag and mask principle should be a useful addition to automatic resuscitators arises from the frequently observed glottic or vocal cord spasm, initiating failure of respiration and accounting for resistance in the air passages. The machine would acquire a wider range of usefulness by allowing the trained operator to increase the positive pressure sufficiently to break through the spasm. It is our opinion that many patients would thereby be saved from irreparable cerebral or cardiac damage.

The effects of positive and negative pressure breathing on respiration and circulation need further elucidation.

Appliances for long-term maintenance of artificial respiration are classified as respirators. In this regard the tank respirator is the most useful device in our country for maintaining respiration in paralytic diseases involving the respiratory system.

Radford, Ferris, and Kriete (15) have devised a Nomogram for predicting the

optimum tidal volume from the breathing frequency, body weight, and sex of the patient. The Nomogram is based on the fact that basal carbon dioxide production and respiratory dead space are related to body size and may be estimated from body weight. Thus this simple practical method, which replaces more elaborate determinations, entails observation and proper setting of spirometric readings and respiration frequency rather than tank pressures to avoid problems of hypo- and hyperventilation.

Cuirass type respirators which cover the anterior and lateral surfaces of the thorax and abdomen are not consistent in sustaining basal ventilatory requirements in apneic patients. For that reason they are classified as weaning devices for convalescent patients who have had a long sojourn in the tank respirator.

The rocking bed, an adaption of the Eve gravity method, is also established as a weaning device. It does not maintain adequate pulmonary exchange when lung or thoracic compliance are much reduced (10).

For the past few months in our hospital we have been working on a simple, self-contained infant resuscitator which can be instantaneously put into service and which is not a bulky addition to the doctor's emergency bag. The heart of the resuscitator is the Fink modification of the Stephen-Slater valve (16). This valve was fitted with a bulb having a low resistance wide bore intake valve. The bulb, as determined on a dry gas Bennett ventilation meter, dispenses an average volume of air ranging between 75 to 80 cc. when compressed fully by the hand. Pressures can be suitably adjusted to avoid overdistension of the lungs through a safety outlet incorporated in the Fink valve. However, since pressure is a function of gas velocity and diameter of the outlet, and whereas the outlet is a constant factor after being set, the velocity of air flow varies according to the energy applied by the hand to collapse the bulb. An ordinary blood pressure manometer acts as a constant check on the energy of the hand squeeze and helps to keep pressures within safe limits. The manometer connects directly to the mask or endotracheal tube adapter and is quickly fastened to the wrist for convenience by means of a malleable metal band covered with rubber tubing. Pressures, to be safe, are not allowed to go beyond 25 to 30 mm.Hg. (17).

Oxygen, if available, can be introduced by connecting a delivery tube to a nipple located in the air intake valve orifice of the bulb. When oxygen is being used the apparatus may carry on as a respirator when the baby has started to breathe spontaneously. This is made possible by wide bore openings throughout and low resistance valves.

Although our resuscitator may bear resemblance to the Goddard-Bennett-Lovelace or G.B.L. hand resuscitator (18, 19), the mechanism of which is not familiar to us, its indications are quite different. Our resuscitator is designed for routine resuscitation and to inflate easily distensible lungs, whereas the high mask-pressure hand resuscitator appears to be intended mainly for cases of severe atelectasis, where cohesive forces are beyond ordinary means of separation without danger of alveolar rupture. We hope that the G.B.L. hand resuscitator will soon be available to us to supplement our instrument in those occasional cases of tenacious atelectasis requiring time-limited, controlled high pressure impulses.

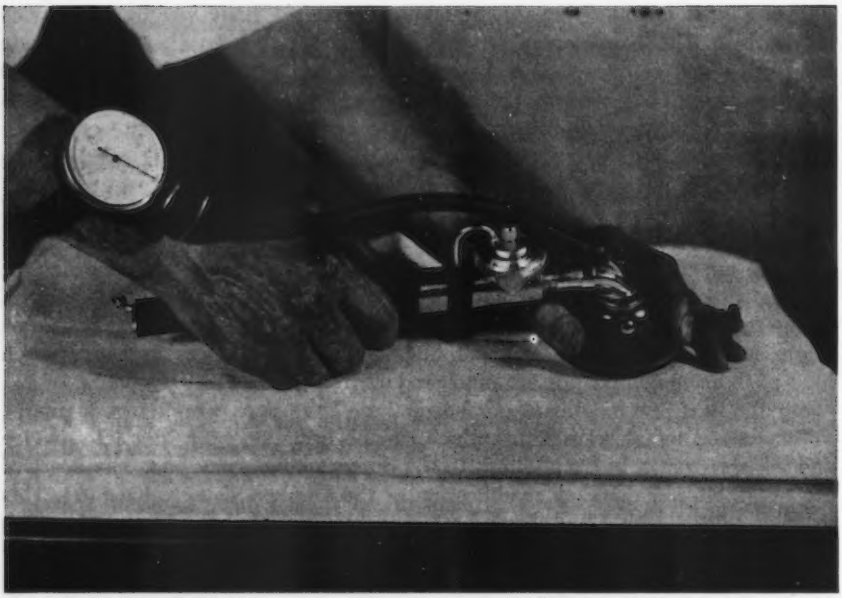

FIGURE 1. Self-contained semi-automatic infant resuscitator with mask, showing manner of fixing blood pressure manometer to wrist for extemporaneous pressure control.

FIGURE 2. Semi-automatic infant resuscitator fitted with endotracheal connector and oxygen delivery tube.

From our preliminary clinical trials, we have reason to believe that this low cost resuscitator (fabricated by us from standard anaesthesia accessories) will be of value to the paediatrician, obstetrician, general practitioner, anaesthetist, and possibly untrained personnel in emergency situations. Further clinical evaluation is required before assessing the usefulness of the apparatus.

Figure 1 illustrates the resuscitator with mask ready for use as a self-contained unit and shows the manner of adjusting the blood pressure manometer.

Figure 2 shows the resuscitator fitted with endotracheal connector and delivery tube from an oxygen supply tank.

Summary

The anaesthetist is well qualified as a specialist to train other doctors and lay personnel in methods of resuscitation. A plea is set forth for a widespread training programme.

The prevention and treatment of respiratory obstruction can be a life-saving procedure in itself, and simple methods for maintaining a clear airway are described. Cases of severe respiratory obstruction in imminent danger of death can be saved by the introduction of a number fourteen trocar through the crico-thyroid membrane, thus providing more ideal conditions for a low tracheotomy.

The time factor is insisted upon in starting manual artificial resuscitation in drowning victims.

Should apparent cardiac arrest accompany cessation of respiration, simple methods of heart stimulation are recommended to be applied simultaneously with artificial respiration.

In an emergency, artificial respiration should be started with immediately available methods such as manual artificial respiration or mouth to mouth breathing.

It is explained that mechanical methods of artificial respiration are intended to replace the operator who has initiated resuscitation by manual methods.

Different types of mechanical devices are described and the advantages of self-contained units not requiring a source of compressed air or oxygen to become operative, are made evident.

It is suggested that a bag and mask device be incorporated in all types of automatic resuscitators to meet individual exigencies of lung compliance.

The use of a Nomogram for patients undergoing long-term maintenance of artificial respiration in a tank respirator is a simple practical means of avoiding consequences of overventilation or hypoventilation.

Cuirass type respirators and the rocking bed are considered as weaning devices and are not recommended for use in apneic patients with low lung or thoracic compliance.

A new type of infant resuscitator incorporating the Fink modification of the Stephen-Slater valve is presented and described. The resuscitator is a self-contained easily transportable unit which is simple in design and operation. It is intended for routine use and is operated at controlled pressures. It is not to be confused with the G.B.L. hand resuscitator which operates at high mask pressures and time limited impulses.

Résumé

L'anesthésiste est tout désigné à l'enseignement des méthodes de resuscitation en raison de sa spécialité qui nécessite l'application de routine des différents méthodes de respiration artificielle. En raison de la fréquence des accidents de submersion, nous recommendons à tous les médecins de diffuser et d'encourager l'enseignement des méthodes de respiration artificielle et de voir à l'organisation des équipes de sauvetage.

La prophylaxie et le traitement de l'obstruction respiratoire est une manœuvre qui en elle-même peut sauver la vie du patient.

Dans les cas d'obstruction respiratoire grave ou la trachéotomie s'impose, nous conseillons d'introduire à travers la membranne crico-thyroidienne un trocard de calibre 14. Cette manœuvre permettra de pratiquer une trachéotomie basse dans de meilleurs conditions et évitera l'atrésie subséquente du larynx.

Pour éviter le problème surajouté de ressuscitation cardiaque, la respiration artificielle doit être instituée dans le plus bref délai possible et ceci s'applique aux victimes de l'onde d'où la nécessité d'équipes de sauvetage bien entrainées.

Dans l'urgence la respiration artificielle devrait être instituée par des moyens immédiatement à la portée de l'opérateur, c'est à dire soit par manœuvre manuelle ou par respiration bouche à bouche.

Les appareils mécaniques sont tout indiqués pour remplacer l'opérateur épuisé qui a initié la ressuscitation par des méthodes manuelles.

Il y a une grande variété d'appareils mécaniques mais ceux que l'on peut mettre en branle sans une source d'oxygène ou d'air comprimé comportent parfois le plus d'avantages.

L'on recommande l'adaptation d'un dispositif spécial sur les appareils automatiques de façon à augmenter la pression positive à volonté dans les cas de pathologie pulmonaire qui exige une pression au delà de celle prédéterminée sur les appareils.

Les appareils citernes pour ventilation pulmonaire à long terme peuvent être ajustés d'une façon pratique aux exigeances métaboliques du patient au moyen d'un Nomogramme. Tout en éliminant les épreuves laborieuses, le Nomogramme permet d'éviter les effets d'hyperventilation ou d'hypoventilation.

Les appareils de type cuirasse inspirent confiance aux patients en assistant la ventilation pulmonaire spontanée au moment de sevrage de la citerne après la phase aigue de poliomyélite.

Nous donnons la description d'un ressuscitateur pour nouveau-né. Cette innovation comporte une soupape de Fink, modifié d'après celle de Stephen et Slater.

Ce ressuscitateur utilise l'air ambiant ou l'oxygène. Cet appareil minuscule facilement transportable peut être utilisé pour ressuscitation de routine soit à l'Hôpital, soit à domicile. Sa mise en branle est très simple et comporte l'avantage de pressions contrôlées extemporanément. Les épreuves cliniques de cet appareil doivent se poursuivre davantage avant d'établir son évaluation au point de vue commodité et efficacité d'une façon définitive.

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THE COMBINED USE OF NISENTIL® HYDROCHLORIDE AND LEVALLORPHAN TARTRATE FOR THE SUPPLEMENTATION OF NITROUS OXIDE–OXYGEN ANAESTHESIA

A Preliminary Report

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The clinical advantages of supplementing N_2O–O_2 anaesthesia with Pentothal® Sodium† and an analgesic of the morphine class, rather than with Pentothal alone, have been adequately demonstrated (1, 2, 3, 4, 5, 6). It has been shown recently by Siker *et al.* (7) that Nisentil Hydrochloride† (1, 3-dimethyl-4-phenyl-4-propionoxy-piperidine hydrochloride), because of its short duration of action and excellent controllability, is the analgesic of choice for this purpose. These workers reported that the mg/min dose of Pentothal was greatly decreased if Nisentil rather than Demerol,® was used for supplementation. However, their attempts to reduce further the Pentothal requirements, by increasing the Nisentil dose, failed because of the marked respiratory depression encountered. Since studies by Swerdlow *et al.* (8) in unanaesthetized patients showed that the narcotic antagonist, levo-3-hydroxy-N-allylmorphinan tartrate (levallorphan tartrate),† offers considerable protection against Nisentil-induced respiratory depression if these agents are used in a 1:50 ratio, the idea occurred to one of us (L.A.P.) that the combined use of Nisentil and levallorphan for supplementation of N_2O–O_2–Pentothal anaesthesia may make it possible to use larger quantities of Nisentil, without producing respiratory depression, and thus reduce further, or eliminate completely, the Pentothal requirements. This seemed desirable in view of the relatively slow rate of degradation of Pentothal in the body (9, 10). Consequently, clinical trials which would utilize Nisentil-levallorphan combinations were initiated.

So far 452 patients, who underwent a variety of surgical procedures, were studied. Of these, 182, who did not require endotracheal intubation, did not receive a muscle relaxant; 78 were given Anectine® (succinylcholine) Chloride for intubation only; and in 192 relaxation was maintained with Anectine throughout anaesthesia. In these three groups 90, 37, and 75 patients, respectively, received Nisentil and levallorphan from a premixed solution and the remaining 250 patients were given levallorphan first followed by Nisentil. By thus combining these two agents, satisfactory operating conditions could be obtained without the use of Pentothal in 58, or 32 per cent, of the 182 patients who did not

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†For brevity Pentothal Sodium will be referred to hereafter as Pentothal; Nisentil Hydrochloride as Nisentil; and levallorphan tartrate as levallorphan.

require intubation. In the remaining 124 patients of this group and in the 270 patients who were intubated, small amounts of Pentothal were used.

The technique which utilizes the administration of levallorphan before Nisentil will be described.

Patients were premedicated with 50-100 mg. of pentobarbital sodium, given 90-120 minutes before operation, and with a combination of 5-10 mg. of morphine sulfate, or 50 to 100 mg. of Demerol, and 0.3-0.4 mg. of scopolamine hydrobromide, administered subcutaneously 45-60 minutes prior to induction of anaesthesia.

Upon arrival in the operating room, the patient's mouth and pharynx were sprayed with a 1 per cent tetracaine hydrochloride solution and an intravenous infusion was started. All subsequent injections were made into the rubber sleeve of the intravenous tubing.

Levallorphan 0.02 mg/kg was administered, followed, after 3-6 minutes, by an initial Nisentil dose of 1 mg/kg (1:50 ratio). In old and debilitated patients half these amounts were given. A 4 litre to 1 litre N_2O–O_2 mixture was then administered by face mask in a semi-closed circuit for 3-5 minutes and an oropharyngeal airway inserted.

If the patient resisted the insertion of the airway, 2 to 8 cc. of a 2½ per cent Pentothal solution were administered in 1 to 2 cc. increments until the airway was readily accepted. A few cc. of Pentothal solution were used before insertion of the airway in all patients who were to be intubated. Endotracheal intubation was facilitated by the intravenous administration of a single dose of Anectine (11) in patients who did not require prolonged muscular relaxation and by continuous intravenous infusion of this agent in instances in which muscular relaxation was to be maintained throughout surgery. Patients were manually hyperventilated with 100 per cent O_2 before intubation. Following the insertion of the oropharyngeal airway, or the endotracheal tube, the bag of the anaesthesia machine was washed out three times with the 4 litre to 1 litre N_2O–O_2 mixture. Thereafter, the flow rates of N_2O and O_2 were each reduced to 500 cc. per minute, according to a previously described technique (12).

If the depth of anaesthesia was not sufficient at the beginning of surgery, additional doses of Nisentil were administered in 10-20 mg. increments, 2-3 minutes apart, until the desired depth of anaesthesia was obtained. When this could not be accomplished without depressing the respiratory rate below 12, additional Pentothal was given in 1-2 cc. increments, 2-3 minutes apart. On occasion, when the duration of the surgical procedure exceeded 2-3 hours, an additional dose of 0.4-0.6 mg. levallorphan was injected. The administration of additional 5-10 mg. doses of Nisentil was governed by signs of lightening of anaesthesia (voluntary movements, breath holding, irregular breathing, tachypnea).

To ensure adequate alveolar ventilation, respirations were assisted by manual compression of the breathing bag throughout anaesthesia.

Table I summarizes the average doses (mg/min) of Pentothal and Nisentil used in the three groups of patients who received levallorphan prior to Nisentil and in comparable groups of patients who were not given levallorphan.

TABLE I

COMPARISON OF THE AVERAGE PENTOTHAL SODIUM AND NISENTIL HYDROCHLORIDE REQUIREMENTS OF PATIENTS ANAESTHETIZED WITH N_2O–O_2, WITH OR WITHOUT THE PREVIOUS ADMINISTRATION OF LEVALLORPHAN TARTRATE

Muscle relaxant	Levallorphan tartrate	Pentothal sodium (mg/min)	Nisentil HCl (mg/min)	Patients reacting (%)
Not used	Used	4.11	2.74	98
	Not used	9.8	0.49	77
For intubation only	Used	3.83	1.92	94
	Not used	8.4	0.48	87
For maintenance	Used	3.37	2.17	95
	Not used	6.4	0.41	84

As is seen, the administration of levallorphan permitted an approximately 50 per cent reduction of the Pentothal requirements as compared with the requirements when no levallorphan was employed. Conversely, when levallorphan was given, the Nisentil doses could be markedly increased. In spite of the four- to fivefold increase of the Nisentil doses, no serious respiratory depression was encountered when Nisentil was preceded by levallorphan. The initial and terminal respiratory rates of the patients who received levallorphan were of the same order of magnitude. Of the 182 patients who did not receive a muscle relaxant only a very few developed apnea which lasted 2-10 minutes. In the majority of patients in this group, the unassisted tidal volume was between 300 and 400 ml. No postoperative respiratory depression was observed in any of the patients.

The average initial and terminal pulse rates and the average initial and terminal blood pressure readings of the patients included in this study were practically identical. No marked increase of pulse rate and no significant fall of blood pressure were observed that could not be explained by the operative procedure. However, in spite of adequate CO_2 removal, a marked increase of the systolic blood pressure occurred in approximately 5 per cent of the cases during anaesthesia. This was usually observed in patients with hypertension, hyperthyroidism, or duodenal ulcers. In these instances, the administration of one or two 5 mg. doses of Hexameton® (hexamethonium) Chloride returned the blood pressure to preoperative levels.

Irrespective of the duration of anaesthesia, over 90 per cent of the patients reacted to auditory or tactile stimulation within 5 minutes after discontinuation of N_2O–O_2 (see Table I). On recovery, patients seldom complained of pain and over 50 per cent did not require analgesics for 8 hours after surgery.

More extensive studies with Nisentil-levallorphan combinations are under way. We are prompted to publish this preliminary report in order to invite the attention of other workers to this promising approach to balanced anaesthesia.

SUMMARY

A technique is described which utilizes the combined administration of Nisentil Hydrochloride and levallorphan tartrate, in a 50:1 ratio, for supplementation of N_2O–O_2–Pentothal Sodium anaesthesia. The possibility of employing large doses of Nisentil, without producing respiratory depression, was demonstrated in 452 patients. In 32 per cent of the patients, who did not require endotracheal intubation, the use of Pentothal could be eliminated. In the remaining 68 per cent, who did not require intubation, and in the patients who required muscular relaxation, the Pentothal requirements were reduced by approximately 50 per cent, as compared with patients who received Nisentil without levallorphan. Over 90 per cent of all patients reacted to stimulation within 5 minutes after discontinuation of N_2O–O_2 and 50 per cent did not require analgesics during the first eight postoperative hours.

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EMERGENCY PAEDIATRIC ANAESTHESIA*

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THE anaesthetic management of the child with a full stomach, admitted for emergency surgery, presents a major problem. We are faced with maintaining an unobstructed airway against a potential hazard lurking in the stomach of almost every accident case. Statistics prove that we are frequently unsuccessful. In obstetrical anaesthesia, a similar problem exists. Merrill and Hingson (1) made a comprehensive survey of the major hospitals of the United States between 1945 and 1949, reporting 67 aspiration deaths, these being 2 per cent of the total maternal deaths. Wylie and Morton (2), reporting recently in the British journal *Anaesthesia*, list 43 deaths due to aspiration. Although this suggests the magnitude of the problem, everyone is aware that the majority of these cases are not reported at all. There is the additional factor of postoperative morbidity to be considered.

I would like to discuss this important, but often disregarded subject under several main headings: (1) Factors predisposing to gastric retention and vomiting; (2) Anaesthetic level associated with vomiting; (3) Types of vomiting and aspiration; (4) The pathological picture in aspiration deaths; (5) The conduct of anaesthesia and prophylaxis; (6) Treatment of patients with aspirated vomitus.

FACTORS PREDISPOSING TO VOMITING

Best and Taylor (3) state the normal emptying time of the stomach to be three to four and a half hours. In children, the digestive processes usually stop at the time of shock or trauma. This is the result of circulatory collapse causing generalized body depression including gastric atony (4). It is therefore imperative not to be lulled into a false sense of security by physiological norms. In accident or emergency surgery, we assume the stomach to be full unless there is positive evidence that food has not been taken for the past eight hours. With the superimposed factor of emotional stress, this period may well be increased to twelve hours or longer.

The anaesthesiologist controls two of the most important of these predisposing factors—premedication and anaesthetic agent combined with mode of administration. A judicious selection and wise administration with regard to physiological and pharmacological values will largely govern the success or failure of this hazardous procedure. The agents and mode of administration will be discussed later. With regard to premedication, barbiturates allay fear, do not stimulate the vomiting centre, and cause little delay in gastric emptying time. Morphine and its derivatives are contra-indicated as they stimulate the vomiting centre and decrease gastric motility. Demerol causes little stimulation of the vomiting centre and delays gastric emptying only slightly. Atropine may cause some stimulation of the vomiting centre and may decrease gastric motility. However, its use as an emergency premedicant is justified by its parasympathomimetic protection against barbiturate spasm, and by its drying effect on pharyngeal secretions. These factors

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are vital in such cases for smooth rapid inductions and uncomplicated intubations. For these reasons, at the Hospital for Sick Children we favour atropine, demerol, and barbiturates in sedating emergency patients. A basic schedule for atropine dosage has been placed in the emergency department of our hospital for routine administration by the nursing staff. This provides adequate doses at proper time intervals to allow our emergency surgery to proceed without delays. We utilize atropine in relatively large doses according to the following schedule: 10-15 lb. (1-6 mos.)—Gr. 1/400; 15-30 lb. (6 mos.-2 yrs.)—Gr. 1/300; 30-60 lb. (2-6 yrs.)—Gr. 1/150; over 60 lb.—Gr. 1/100. Although other preoperative drugs are ordered as desired by members of the anaesthetic staff, we feel that a relatively smooth induction is assured by the administration of atropine.

In addition to the predisposing factors of shock and trauma and those controlled by the anaesthesiologist, a third group of specific disease states may lead to gastric retention and vomiting of a more mechanical nature: pyloric stenosis, intestinal obstruction, and peritoneal inflammation.

Anaesthetic Level Associated with Vomiting

Awareness of the danger area of vomiting will guide us in attempting to pass speedily and smoothly through this level and maintain our course at a deeper plane through the duration of anaesthesia. This danger area of spontaneous vomiting is located at the lower level of Stage 2. It is further enhanced by pharyngeal reflexes which are present through plane 1, Stage 3. The sensitivity of the vomiting centre also remains through plane 1 of Stage 3. Obstructive vomiting will occur at any depth, as it is a mechanical problem. Lundy (5) has stated that on emergence from Stage 3, vomiting appears immediately after swallowing. Swallowing occurs during the lightest anaesthesia of Stage 3 and vomiting during the deepest of Stage 2. Warning signs of vomiting are shallow respiration, pallor, weak pulse, and contracted pupils. These are warning signals that a deeper level of anaesthesia is required.

Vomiting which follows retching, during which the breath is held, is particularly dangerous. The masseter muscles are in firm spasm so that the mouth cannot be opened. The vomitus fills the pharynx and is drawn into the trachea and lungs by the first deep post-retching inspiration.

The actual mechanism of vomiting may be accomplished either by the co-ordinated actions of the muscles of the stomach, oesphagus, and abdominal wall or by the antiperistaltic movements of the intestine. The nervous control (6) is by afferent impulses arising in the stomach or other viscera, or from almost any region of the body, and travelling by the sympathetic and vagus systems to the vomiting centre in the medulla near the dorsal nucleus of the vagus. The efferent fibres are contained chiefly in the phrenics, vagi, sympathetics, the spinal nerves to the abdominal muscles, and the cranial nerves to the muscles of the pharynx, and palate.

Types of Vomiting and Aspiration

This is essentially a classification of degree, with immediate or delayed visible signs (7).

1. Vomiting and aspiration of solid food lodging in the larynx, trachea, or

bronchi may produce total obstruction and death by suffocation. If the obstruction is only partial, the typical picture of obstructive atelectasis is found.

2. An asthmatic type of chemical pneumonitis may result from aspiration of liquid vomitus; clinically cyanosis, tachycardia, dyspnoea, and wheezing are observed. If death occurs, it is due to cardiac failure and pulmonary oedema.

3. There is an insidious type known as "silent" regurgitation and aspiration. Adriani (8) in a series of 926 elective operations disclosed a regurgitation incidence of 14 per cent and aspiration incidence of 7 per cent. The incidence appeared to be unrelated to drugs used or operation performed. It was increased by stormier inductions, difficult endotracheal anaesthesia, and gastric retention or distension. In this series of cases the risk of pneumonitis was negligible if careful endotracheal suctioning was practised and antibiotic therapy instituted. In emergency surgery, there is danger of an equally insidious but more massive aspiration leading to a more severe pneumonitis. Such patients may recover from their anaesthesia with a pain in the chest, blood-tinged sputum, cyanosis, tachycardia, and hyperpnoea.

4. Special mention should be made of the specific type of vomiting observed in cases with intestinal obstruction. A large aspiration may result, in which the patient drowns, or a slow insidious type as mentioned above may occur. Such complications are reduced to a minimum by gastric lavage, leaving the Levine tube in place, associated with endotracheal anaesthesia. In infants about to undergo the Ramstedt operation for pyloric stenosis, we do a preoperative gastric aspiration routinely, usually obtaining large amounts of secretions and undigested feedings. A Levine tube is left *in situ* during the actual operation, for further drainage.

The route followed by this aspirated material depends on the bronchial configuration; right-sided passage is favoured (9). The most frequent site is the apical branch of the lower lobe with the patient lying on the back. With the patient in the lateral position, the most common site is the subapical posterior and axillary portions of the upper lobe.

Pathological Picture in Aspiration Deaths

The post-mortem examination reveals no atelectasis because of the presence of aspirated material and bronchial exudates. The lungs are increased in weight. The gastric contents cause a chemical breakdown of the blood, making it much darker in colour. There is hyperaemia of the bronchial tree and gastric dilatation. Microscopically, the alveolar spaces reveal capillaries engorged with erythrocytes and edema and particles of undigested food. Marked desquamation has usually occurred along the lining of the bronchial tree.

Conduct of Anaesthesia

The procedure followed at the Hospital for Sick Children is as follows:

1. The time interval between the last food eaten and the proposed operation will govern the anaesthetic technique to be employed. A careful history is taken from the parent, and if the child is old enough, from the child as well, to determine how long before the accident or acute illness food was taken. Information from both these sources is of equal importance—the parent will

disclose the home menu while the child will often reveal outside snacks. Such data are recorded routinely on every emergency anaesthetic chart by our nursing staff in spaces marked "nature of last nourishment" and "time." Our anaesthetic staff usually rechecks this important information. A positive history warns us to take every precaution and alerts us as to the nature, type, and amount of vomiting to expect in the postoperative period. Although a negative history offers us some assurance, it is wise to be extremely guarded in such cases with children.

2. All non-urgent operations, falling into an elective category, are postponed until the following day or until an adequate time interval has elapsed.

3. Whenever possible, local or regional anaesthesia is employed. The use of these methods is relatively restricted in children.

4. I should like to stress, particularly, the importance of the preparation of equipment. This should be ready in every detail, prior to induction, to meet each emergency without catastrophic delay. It includes an operating table readily adjustable to Trendelenburg position, proper suction apparatus of a metal pharyngeal type and rubber nasal type, anaesthetic machine with adequately filled tanks, intravenous or liquid anaesthetic agents and relaxants in complete readiness, airways of proper size, laryngoscope and several endotracheal tubes with connectors attached, adhesive strapping, dental mouth gag, and readily available bronchoscope.

5. The question of mechanical stimulation to initiate vomiting, and gastric lavage to remove stomach contents before inducing anaesthesia, are controversial subjects. We prefer not to employ these techniques. If we do, they are accomplished by insertion of a finger or metal suction into the throat or by the passage of a large stomach tube. This may accomplish the purpose partially but should not lull the anaesthetist into a false sense of security, as solid material may remain. Furthermore, it may initiate a severe psychological disturbance, leading to a stormy induction, with the residual food being vomited in the "danger area."

6. With children whose veins are accessible, we prefer to administer pentothal combined with a relaxant to accomplish smooth, rapid induction. Venipuncture may be accomplished in very small children by use of hypo needles. A 2½ per cent sodium pentothal solution is utilized with 2 mgm. syncurine added to the 20 cc. syringe. One cc. of this mixture is administered per 5 lb. of body weight. Succinylcholine 1 mgm. per 4 lb. may be given to facilitate rapid intubation. The syncurine is a valuable adjuvant in preventing bucking and gastric disturbances and allowing stabilization of the anaesthetic. We prefer to use a snugly fitting endotracheal tube, quickly selecting the proper size among several prepared on our anaesthetic table. The teeth are kept apart by means of a dental mouth gag, so that if vomiting does occur food particles may be removed readily by the fingers and liquid material easily aspirated by suction apparatus. A bite block or airway prevents easy access to the pharynx. It is important that the endotracheal tube be fastened firmly in place, particularly in operative procedures about the face. Liquid solutions used to prepare the surgical area will loosen ordinary adhesive tape, allowing dangerous accidental extubation. This may be obviated by utilizing a water-proof adhesive, such as Sleek®, or by fastening nasotracheal tubes to the external nares and orotracheal tubes to the lip margins by silk sutures.

Maintenance of anaesthesia is accomplished by further doses of intravenous agents as required—nitrous oxide, oxygen, and trilene—utilizing a partial or non-rebreathing technique. We favour this method particularly for fractures in our fluoroscopic room. If there is no explosion hazard and a circle filter machine of proper size is available, cyclopropane may be substituted either for induction or for maintenance.

7. In smaller children, where venipuncture is impossible, induction is accomplished in the lateral Trendelenburg position using vinethene and ether and our best psychological approach. When plane 2 of stage 3 is reached, the patient is placed in the supine position and a snugly fitting endotracheal tube is introduced. The anaesthetic is maintained by ether, nitrous oxide, oxygen, and trilene by the partial rebreathing or non-rebreathing techniques.

The anaesthetic agents mentioned above have no deleterious action on the vomiting centre—there is no stimulation with nitrous oxide, vinethene, and sodium pentothal, and depression occurs with cyclopropane and ether.

8. For recovery the patients are placed again in the lateral Trendelenburg position. The endotracheal tube is left in place, fastened securely by adhesive. The pharynx is kept accessible for manual removal of solid particles and suction removal of liquids by the dental mouth gag. This position is maintained until the cough reflex has returned sufficiently to provide effective control by the patient of any vomited material. The patient is taken back to the recovery room or ward by the anaesthetist. Full instructions are issued to the nurse in charge regarding the state of consciousness and postoperative care.

9. With regard to very minor procedures such as myringotomies, incision and drainage of abscesses, and greenstick fractures, we favour an analgesic technique with vinethene or nitrous oxide and trilene without intubation.

Treatment of Aspirations

The patient is placed in as steep a Trendelenburg position as possible to facilitate gravity drainage of material. Immediate bronchoscopy is imperative to save the patient's life if a major obstruction has occurred. In such an exigency, this becomes the direct responsibility of the attending anaesthetist. Oxygen may be administered through the side arm of the bronchoscope during and following this procedure, for resuscitative purposes. The bronchi are cleared of all offending material, with the bronchoscope remaining in place until reflexes have returned, the general condition is satisfactory, and oxygenation adequate. During the recovery phase chest expansion is encouraged by frequent movement, coughing, and hyperventilation. Antibiotics are administered during the post-operative period. The patient remains in a Trendelenburg position with the administration of oxygen as required.

Summary

Emergency paediatric anaesthesia has been discussed with particular reference to the child with a full stomach.

1. The various factors influencing gastric retention and vomiting have been mentioned.

2. The depths of anaesthesia associated with vomiting and its neurogenic control have been outlined.

3. The various types of aspiration and routes followed by such material under anaesthesia have been discussed.

4. A short outline of the pathological picture of the lungs following aspiration deaths has been presented.

5. Particular emphasis has been placed on the conduct of such anaesthesia as practised at the Hospital for Sick Children.

Résumé

L'anesthésie d'un enfant qui n'est pas à jeun qu'on admet pour chirurgie d'urgence présente un problème majeur.

Bien qu'il soit admis que l'estomac se vide en 3 à 4 heures et demie, les processus digestifs chez les enfants ordinairement s'arrêtent au moment du choc ou du traumatisme. C'est pourquoi, il ne faut pas s'illusioner par un faux sentiment de sécurité basé sur les normes physiologiques. Dans la chirurgie traumatique ou d'urgence nous prenons comme acquis que l'estomac est rempli à moins qu'il y ait preuve certaine qu'il n'a eu aucune ingestion d'aliments durant les dernières huit heures.

La prémedication, les agents anesthésiques et les techniques peuvent influencer les vomissements chez ces enfants. On favorise l'emploie des barbituriques et du Démérol parce qu'ils diminuent l'appréhension et n'excitent pas habituellement le centre du vomissement. Ils ne prolongent pas non plus, ou du moins très peu, le temps nécessaire à l'estomac pour se vider. La morphine et ses dérivés sont contre indiqués. Bien que l'atropine peut stimuler légèrement le centre du vomissement, son emploie se justifie par ses effets parasympatholytiques qui sont nécessaires pour une induction rapide et facile et une intubation sans complication.

Quand l'anamnese suggère que l'estomac est plein, toute intervention élective ou non urgente devrait être remise à plus tard ou faite sous anesthésie régionale si possible. S'il est nécessaire d'employer l'anesthésie générale, la technique préférée employée au "Hospital for Sick Children" de Toronto, consiste en une induction rapide employant un mélange de pentothal et de Syncurine (2 mgm. de Syncurine dans 20 cc. avec 2½% de pentothal—1 cc. par 5 lb. de poids). La Succinylcholine en dose de 1 mgm. par 4 lb. peut être donnée pour faciliter l'intubation qu'on fait rapidement utilisant un tube endotracheal de diamètre adéquat. On maintient la bouche ouverte au moyen d'un instrument de façon à avoir accès facilement au pharynx en cas de vomissement. Une fois l'intubation faite, l'anesthésie est maintenue par un mélange de protoxyde d'azote avec oxygène et trichlorethylene en ajoutant s'il est nécessaire des doses d'agents intraveineux.

À la période du réveil, le tube endotracheal est laissé en place et le patient est placé en position latérale avec tête basse jusqu'à ce que le reflexe de la toux s'est rétabli suffisamment pour permettre au malade un contrôle suffisant de tout matérial vomit. Le traitement de l'aspiration de vomissements se fait par bronchoscopie immédiate.

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A NEW TECHNIQUE OF INTUBATION FOR THE PREVENTION OF CONTRALATERAL INFECTION DURING LUNG SURGERY*

LÉON LONGTIN, M.D., F.R.C.P.(C)**

ESPECIALLY with "wet" lungs and in tuberculous patients, pulmonary surgery has raised the problem of contralateral contamination, a problem which still remains to be solved today. Whose problem is it? Surely not the patient's! The surgeons make the anaesthetists feel it is not the surgeon's problem, so we anaesthetists must try to solve it.

Drainage by position during operation has been tried and found helpful, but not entirely effective. Separate intubation of both main bronchi has been thought to be the solution of the problem, but the technical application of that principle has been hard to realize and does not seem to be properly realized yet.

For pulmonary surgery we have tried, at St. Joseph Sanatorium, Rosemont, Montreal, to build a separate air-tight circuit for each lung, using a technique we think is new.

DESCRIPTION OF THE TUBES

The technique consists in placing two separate tubes in the bronchial tree of the patient: one of these tubes, specially built for that purpose, is placed in the left main bronchus; the other one, an ordinary tracheal tube, is placed in the trachea as is usually done for tracheal intubation.

The specially built tube is thin-walled and a little hard to bend. It varies in size and length according to the dimensions of the bronchial tree of the patient, from 3 to 6 mm. in diameter and 25 to 32 cm. in length. At its distal extremity, about 2 cm. from the end, there is a small curvature to the left, and the bevel is so cut that it naturally enters the left bronchus when arriving at the carina. Just below the bevel there is a small inflatable cuff which, when inflated, makes an air-tight circuit with the left lung. At 7 or 8 cm. above the cuff, there is another inflatable cuff which, when the tube is in place, is supposed to be about 2 cm. below the vocal cords.

The tracheal tubing has a diameter equal to the bronchial one, and is of proper length to reach 2 cm. below the vocal cords. This tube has, at its distal end, two cuffs—one near the bevel, and the other one just above the first. To make an air-tight circuit with the right lung, sometimes, we have had to inflate three cuffs, the upper one on the bronchial tube and the two others on the tracheal tube.

Each tube is connected with a separate anaesthetic machine, where different anaesthetic atmospheres may be employed at different pressures in the circuit, according to the requirements of the patient or of the surgeon, with different

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**L'Hôtel-Dieu, Montréal, and l'Université de Montréal.

kinds of breathing systems: closed, semi-closed. Since the circuits are completely independent, they are just like two different patients.

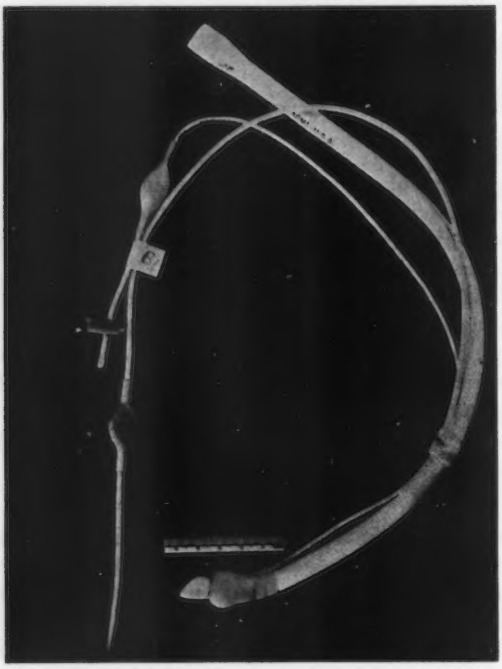

FIGURE 1. Tube bronchique à bout incurvé à gauche, portant deux ballonnets dont l'un, le distal, ne gonfle que sur un centimètre de longueur pour établir un circuit étanche avec le poumon gauche.

DESCRIPTION OF TECHNIQUE

A few essential conditions are required to facilitate such intubation. The most important one is to have a deeply anaesthetized and well-relaxed patient. The deep anaesthesia prevents coughing during and after intubation and also prevents the displacement of the tube. Good relaxation, usually obtained by succinylcholine, helps in putting the tubes in place. In addition it is advisable to use well-lubricated tubes. This lubrication is usually done with soluble jelly containing anaesthetic agent but no vasopressor drug.

A second pair of hands may, sometimes, be helpful in checking the position of the tubes and the tightness of the circuits.

It is advisable that bronchial intubation be performed on the left side, though it can be done more easily on the right side. When done on the right side, there is a greater risk of occlusion of the upper lobe bronchus by the tube and protection against infected secretions is not so completely effective.

During operation, suction can be done in one circuit without interfering with the other one, but it is advisable to have one catheter for each lung to prevent contamination of the healthy side by the catheter.

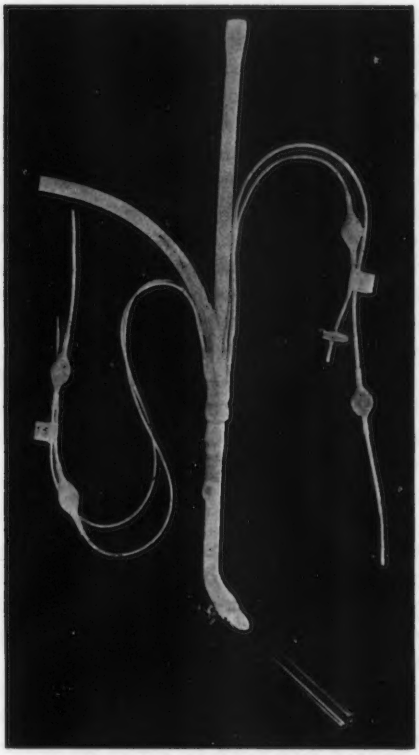

FIGURE 2. Les deux tubes, bronchique et trachéal, en place dans un arbre bronchique en verre. Notez la position des ballonnets supérieurs pour établir un circuit étanche avec le poumon droit.

How to Clean the Bronchial Tree at Extubation

In our opinion, extubation may be the very moment when contralateral contamination may occur. For proper cleaning of the bronchial tree at extubation when two tubes are used, we suggest the following technique. Suction must be done first through the tracheal tube. When that part of the bronchial tree is well cleaned, the upper cuff of the bronchial tube and both cuffs of the tracheal tube are deflated; then the tracheal tube is pulled out while the suction catheter remains in its lumen to aspirate the secretions gathered around the cuffs. After a good cleaning of the main left bronchus, the distal cuff of the bronchial tube is deflated and the same technique is followed to pull out the bronchial tube: that is, the suction catheter is left in the lumen of the tube while it is pulled out to complete the removal of all secretions.

We feel that this technique permits a more adequate suction of infected secretions than does the double lumen tube. As a matter of fact, suction catheters do not pass easily through double lumen tubes, and, when aspirating the right side, it is impossible to clean the trachea before deflating the distal cuff in the

left bronchus. When deflating that cuff in such circumstances, the infected secretions, gathered around the bronchial tubing between the two cuffs during the operation, may enter the left bronchus and spread the infection. At that moment the goal is missed.

Since January 1954, we have used the two-tube technique in about fifty cases of lung surgery. We feel it gives a quite complete security against contralateral contamination. It is easy to manage and to keep in place. It can be used even in deviated trachea. Suction is more easily and more adequately done.

Proper size and length of tubes are chosen for each patient, with the aim of avoiding excess of resistance and dead space.

The use of two machines with this technique and the maintenance of a steady positive pressure of 2-5 mm. of mercury in the lung opposite to surgery prevents the shifting of the mediastinum and its consequent circulatory disturbances.

This technique is especially valuable in plastic surgery of the bronchi and in cases where both pleurae are opened; all cases where contralateral infection is feared during operation will be adequately protected in any position, with a technique which is easy for the anaesthetist to follow.

Résumé

Cette technique consiste à placer dans la bronche gauche du malade un tube spécialement construit, de diamètre et de longueur appropriés pour chacun des malades; ce tube possède, à deux centimètres de son extrémité distale, une légère incurvation et un biseau taillé de telle sorte que, naturellement, le tube se place dans la bronche gauche quand il arrive à la carène. Ce tube bronchique porte deux ballonnets: l'un a son extrémité distale, près du biseau, mesurant environ un centimètre de longueur, ne dépassant pas la bronche souche gauche quand il est gonflé; l'autre, à 4 ou 5 cm. au-dessus du premier, ballonnet détachable ordinaire, servant, si nécessaire seulement, à établir un circuit étanche dans le poumon droit à l'aide du tube intra-trachéal.

Quand le tube bronchique est en place dans la bronche gauche, on introduit dans la trachée un tube trachéal ordinaire, porteur, à son extrémité distale, de deux ballonnets: l'un est placé près du biseau du tube et l'autre immédiatement au-dessus du premier. Pour obtenir un circuit étanche dans le poumon droit, il arrive qu'il soit nécessaire de gonfler ces deux ballonnets et le ballonnet supérieur sur le tube bronchique. Chacun de ces tubes est mis en communication avec une machine à anesthésie où peuvent être introduites des atmosphères anesthésiques différentes, à des pressions différentes, sous des formes différentes de circuits, tout comme s'il s'agissait de deux malades différents.

Pour mettre ces deux tubes en place et pour éviter que le malade les déplace en toussant après qu'ils sont installés, certaines précautions sont recommandables: il faut avoir un malade sous anesthésie profonde et bien relaché. Il est également souhaitable d'avoir un tube bien lubrifié.

A notre avis, la contamination contro-latérale peut survenir surtout au moment de l'extubation. Pour prévenir adéquatement cette contamination quand deux tubes sont employés, nous suggérons de procéder ainsi: à travers le tube trachéal, nettoyer la trachée et la bronche droite à maintes reprises et, après avoir dégonflé

les deux ballonnets sur ce tube et le ballonnet supérieur sur le tube bronchique, enlever le tube trachéal en laissant la sonde aspiratrice dans la lumière du tube trachéal pour continuer de débarrasser la trachée des sécrétions qui pourraient s'y trouver; ensuite, avec une sonde aspiratrice propre, nettoyer la bronche gauche à travers la lumière du tube bronchique et, après avoir dégonflé le ballonnet distal sur le tube bronchique, en laissant la sonde dans le tube bronchique comme pour le tube trachéal, retirer lentement le tube bronchique en aspirant, encore une fois, les sécrétions ou le sang venant du mognon bronchique qui pourraient se rencontrer dans la trachée.

L'usage d'un circuit différent pour chacun des poumons s'avère très utile au cours de la chirurgie pulmonaire ordinaire, mais cette technique est particulièrement appréciée pour la plastie des bronches et dans les cas où les deux plèvres sont ouvertes.

Il s'agit d'une technique d'intubation facile à appliquer et réalisant une protection adéquate contre l'infection contro-latérale au cours de la chirurgie pulmonaire.

REFLECTIONS OF AN ANAESTHETIST RETURNING HOME

Friday, June 24th

The meeting is over and the family bus is rolling us home. Have just passed Oshawa where we left Ted Gain to pick up a new car. I sure hope the new Oldsmobile will hold together until they arrive in Alberta. At Oshawa, I turned the driving over to the girls and crawled into the back seat to dose and meditate. There has not been much time for contemplation the last few days.

It has been a very stimulating meeting. Too bad about the boys who had to stay home to do the work, and, particularly, those Toronto boys who did their share for the meeting, and, also, did the work. That does keep you busy!

Toronto was certainly the place to have this meeting, and what a reunion it was for the Varsity men after years away. Our teachers were all there. Doctors Shields, Stanley Campbell, Rupert Balfour, John Chassels, Bill Brown, and Norman Clark—the ones that used to put us to work and get us out of trouble. We like to remember that years ago there was no one handier with a laryngoscope and tube than Norman Clark; and, of course, Bill Brown told the "Cyclopropane Story." These men must be proud of the departments they have built; the University Department they have seen expand, function, and produce men and results. And, they are certainly producing! That paper by Stuart Vandewater on "Hypothermia in Neuro-surgery" was excellent; and Code Smith's paper on "Paediatric Anaesthesia" was a good one too.

The programme was fine. It was a bit crowded at times, but, knowing the problems entailed in organizing a meeting of such scope, that was inevitable. There certainly was not time to take notes, but the JOURNAL will have all the papers for more leisurely perusal and assimilation.

There could hardly have been better representation from all parts of Canada. Despite the sticky weather, everyone peeled off their coats and listened. Golfing was not much of a distraction. George Bigelow did the golfing for the whole meeting this year.

The representation from "South of the Border" was encouraging too. We have enjoyed their hospitality many times and, we hope, they enjoyed this trip to Canada.

The excellent representation from the United Kingdom made the meeting historical. All Canadians who have not been "over" recently were glad to meet the men whose articles they have found interesting and stimulating. Their contributions, both historical and scientific, were of a high calibre. I am more convinced than ever that our Canadian trainées should all have the benefit of the influence and teaching available in Great Britain.

It was a pleasure to have Sir Robert MacIntosh there. He rapidly acquired the devotion and respect of all present, and his contributions to the meeting were more than scientific. His forthright attitude and refreshing humour will long be remembered. We could not have had a better ambassador at the General Sessions.

Joe O'Donnell conducted the Annual Dinner well. Doctor Wesley Bourne was really up to form, and Sir Robert is one of the few who has ever been able to make an entertaining after-dinner speech out of the specialty of Anaesthesia. Where did all the people go during the dance? They could not possibly have all gone down to the pub.

And so it is over! And, a good thing it is that all appreciated the contributions made by Rod Gordon in organizing, entertaining, keeping the meetings on schedule, and tactfully steering the immature new President through his first sessions. And Rod would, of course, have been quite helpless without Ruth at home, and Miss Campbell at the office.

We hope for health and adequate prosperity for a repetition of this experience in Edinburgh in 1959.

Well, we are getting near home. I'd better get into the front seat and do some of the driving.

ALAN NOBLE

CORRESPONDENCE

Toronto General Hospital,
Toronto, Ontario.
11th July, 1955

The Editor,
The Canadian Anaesthetists' Society Journal,
516 Medical Arts Bldg.,
Toronto 5, Ontario.

SIR,

If a new member of the Canadian Anaesthetists' Society may be permitted to utilize some space in the JOURNAL, I should like to ascertain the views of other anaesthetists on the subject of the clinical distinction between the different types of prolonged myoneural block, which may follow the use of the so-called depolarizing muscular relaxants.

For some years it has been my practice, from time to time, to use an anaesthetic sequence in which the balance is tilted towards large doses of relaxant, rather than of general depressant. Using such a sequence, it has occasionally been my misfortune to be faced with prolonged muscular relaxation. This has been the case in a few patients given intermittent doses of decamethonium compounds.

Early in 1950, a patient requiring an abdomino-perineal resection of rectum, who had been given intermittent doses of decamethonium, remained apnoeic post-operatively for a total of about 2½ hours. Whilst he was, at first, totally apnoeic, he subsequently recovered some respiratory activity though this was quite inadequate. With some considerable trepidation, Atropine and Prostigmine were given—followed by the patient's complete and immediate recovery (1). Since then, greater experience with the drug has prevented such gross examples of this phenomenon but more minor incidents have been successfully treated in the same manner.

Now that the phenomenon of "mixed block" (2) is a current subject for discussion, the clinical distinction of the types becomes important. In which cases is it safe to give Prostigmine? I would venture to suggest, sir, that those patients in whom respiratory activity is present but is inadequate (as shown by "see-saw" respiration etc.), and in whom this phase has persisted for, say, 15-30 minutes, may be the group to whom Prostigmine may be given. Needless to say, the possibility of a raised blood pCO_2 should be eliminated, first, by a trial of hyperventilation through an efficient CO_2 absorber.

No apnoeic patient who has received a depolarizing agent should be given Prostigmine.

Yours faithfully,

H. BARRIE FAIRLEY, M.B., B.S., F.F.A.R.C.S.

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NEWS LETTER

British Columbia Division

Dr. James Blair Fulton, who recently completed his training in Anaesthesia leading to Fellowship, has joined Associated Anaesthetic Services and the Staff of the Vancouver General Hospital.

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Donald Matheson, M.B., Ch.B., B.A., F.F.A.R.C.S. (England), has joined Associated Anaesthetic Services and the Staff of the Vancouver General Hospital.

°

Dr. Maria Mate, who recently completed her training in Anaesthesia at the Vancouver General Hospital, has joined the Staff of St. Paul's Hospital, Vancouver, B.C.

°

Dr. Leonard Cecil Jenkins has been awarded the Burroughs-Wellcome, Poulenc Ltd., and Abbott Laboratories Fellowship in Basic Sciences at the University of British Columbia.

°

Dr. J. M. Hiddleston, who recently completed a year in Basic Sciences at the University of British Columbia, is taking six months' residency in Anaesthesia at the Royal Infirmary, Glasgow, Scotland.

°

Dr. James K. Whittal, who recently was with the Department of Public Health, British Columbia, has commenced his anaesthesia training at the Shaughnessy Veteran's Hospital, Vancouver, B.C.

°

Dr. John H. Harland, who recently practised in Kamloops, British Columbia, has commenced his Fellowship training in Anaesthesiology at the Vancouver General Hospital.

°

Dr. Horace B. Graves will represent Associated Anaesthetic Services at the World Congress of Anaesthesiologists, Schevenigen (Holland), September 5-10, 1955.

°

Tenders have been called for a 500-bed addition to the Vancouver General Hospital.

Alberta Division

The officers of the Alberta Division for 1955-56 are:

Chairman: Dr. Frank E. Lundy, Calgary.

Secretary-Treasurer: Dr. Rhoda B. Robertson, Calgary.

Saskatchewan Division

The officers of the Saskatchewan Division for 1955-56 are:
Chairman: Dr. M. Vivyan Morton, Saskatoon.
Secretary-Treasurer: Dr. C. J. Kilduff, Saskatoon.

Manitoba Division

Dr. Jack Brener, Head of the Department of Anaesthesia of the Misericordia Hospital, was appointed Acting Superintendent of the Hospital in April 1955.

*

A number of the members of the Anaesthetic Staff of the St. Boniface Hospital have moved either permanently or temporarily. Dr. T. J. Halkiewicz has left to join the Anaesthetic Staff of the Grace Hospital in Toronto. Dr. Henry Devlin has also left for Toronto. He will be associated with the group at the Humber Memorial Hospital, Weston.

*

Dr. Thomas F. Todd is taking a one-year residency at the University of Minnesota with Dr. Van Bergen.

*

Dr. Guenther Semelka will join the St. Boniface Anaesthetic Clinic on August 1, 1955.

*

Dr. T. J. McCaughey, D.A., recently from Newfoundland, has joined the Anaesthetic group at the Winnipeg General Hospital. He is a graduate of Belfast, Ireland.

*

Dr. Jack Crawford from Ipswich, England, has joined the group of Associated Anaesthetists of Winnipeg. His wife and child recently arrived from the Old Country to join him.

*

Dr. Myrl Gard, a recent graduate of the University of Manitoba, has started her training as Assistant Resident in Anaesthesia at the Winnipeg General Hospital.

*

The Operating Rooms in the new wing at St. Boniface Hospital were opened on the 22nd of July. To the local medical profession they represent all that is most up-to-date and efficient in operating room and anaesthetic service.

*

At the monthly meeting in May, the Winnipeg Anaesthetic Society elected the slate of officers for the coming season:

President: Dr. David Tass.
Vice-President: Dr. J. I. Davies.
Secretary-Treasurer: Dr. A. W. Natsuk.

Ontario Division

The Ontario Division are planning to hold a meeting in Windsor in October 1955. Definite dates will be announced to members of the Division later.

•

The following retirements, promotions, and new appointments have been made in the Department of Anaesthesia, Faculty of Medicine, University of Toronto, as of July 1, 1955:

Dr. A. Ralph Hargrave, Associate in Anaesthesia, has retired and relinquished his appointment as Chief Anaesthetist at the Toronto Western Hospital. He has been succeeded by Dr. H. Rice Meredith.

Dr. Douglas Bastow has retired from his teaching appointment on the University staff.

Promotions

Dr. R. A. Gordon, Toronto General Hospital, from Clinical Teacher to Associate.

Dr. C. Ivan Junkin, Hospital for Sick Children, from Clinical Teacher to Associate.

Dr. Shirley Fleming and Dr. Stuart L. Vandewater, Toronto General Hospital, from Clinical Assistant to Clinical Teacher.

New Appointments as Clinical Assistants

Dr. Paul Bailey, at St. Michael's Hospital.

Dr. G. W. Dix, Dr. Margaret Sheehan, Dr. F. Van V. Snell, Dr. J. S. Whalen, at the Hospital for Sick Children.

Dr. Garnet Dixon, at the Toronto Western Hospital.

Dr. H. B. F. Fairley, at the Toronto General Hospital, from Registrar in Anaesthetics at the Brompton Chest Hospital, London, England.

Resident Fellows in Anaesthesia for one year

Dr. Ian S. H. Harper, at the Toronto General Hospital.

Dr. J. G. Robinson, at the Hospital for Sick Children.

Dr. Leonard Weston, at the Toronto Western Hospital.

Dr. J. F. MacIntosh, at the Toronto East General Hospital.

•

Dr. W. E. Martin has retired as Chief of the Department of Anaesthesia at the Toronto East General and Orthopaedic Hospital, and Dr. R. A. Chaplin has been appointed as Chief of the Department.

•

Officers of the Ontario Division, Canadian Anaesthetists' Society, for 1955-56 are:

Chairman: Dr. R. A. Chaplin, Toronto.
Members of Council: Dr. J. Gorman, Windsor.
Dr. R. Probert, Hamilton.
Dr. J. Wishart, Peterborough.
Secretary-Treasurer: Dr. G. F. Smith, Toronto.

Quebec Division

Dr. Alan B. Noble has been appointed Chief of the Department of Anaesthesia of the Royal Victoria Hospital, Montreal. Dr. Noble has been Chief of the Department of Anaesthesia at the Hôtel Dieu Hospital, Kingston, Ontario.

•

We record with regret the death of Dr. Walter Stockwell, of the Anaesthetic Staff of the Royal Victoria Hospital, Montreal. Dr. Stockwell died on June 20, 1955.

•

The officers of the Quebec Division, Canadian Anaesthetists' Society for 1955-56 are:

Chairman: Dr. Marius Dubeau, Montreal.
Members of Council: Dr. H. R. Griffith, Montreal.
Dr. Louis Lamoureux, Montreal.
Secretary-Treasurer: Dr. W. G. Cullen, Montreal.

New Brunswick Division

The officers of the New Brunswick Division for 1955-56 are:
Chairman: Dr. A. M. R. Brown, Saint John.
Secretary-Treasurer: Dr. T. Lunney, Saint John.

Nova Scotia Division

The officers of the Nova Scotia Division for 1955-56 are:
Chairman: Dr. R. A. P. Fleming, Halifax.
Secretary-Treasurer: Dr. A. S. Wenning, Halifax.

Newfoundland Division

Dr. I. Levitz and Dr. C. Henderson of St. John's have completed courses in anaesthesiology, and have been certificated. Both are now in the private practice of Anaesthesia at St. John's, and are on the staff of the St. John's General Hospital.

•

There are presently five certificated anaesthetists on the staff of the St. John's General Hospital.

CANADIAN ANAESTHETISTS' SOCIETY ANNUAL MEETING, 1956

The Annual Meeting for 1956 will be held at Mont Tremblant Lodge, Mont Tremblant, Quebec, on June 18, 19, 20, 1956. In order that the best possible programme may be arranged, it is essential that all individuals wishing to present papers at this meeting should advise the Secretary at the earliest possible date. Since programme and meeting arrangements must be finalized prior to March 1, 1956, it is requested that title and summary of the subject to be presented should reach the Secretary not later than November 1, 1955.

BOOK REVIEWS

PHARMACOLOGY. By J. H. GADDUM, S.C.D., F.R.S., M.R.C.S., L.R.C.P., Professor of Pharmacology, University of Edinburgh. 4th ed., London: Oxford University Press. 1953. Pp. 562. $5.25.

This textbook of Pharmacology is intended primarily for undergraduate medical students, as stated in the Preface. It does not contain sufficient material to be used as a reference for the specialist or postgraduate student in Anaesthesia. However, the chapters on muscle action and relaxants, narcotics and anaesthetics, though brief, may serve as a review for the occasional anaesthetist, and suggested reading for the undergraduate. The format is excellent, and the text is easily read.

S. L. V.

FUNDAMENTAL CONSIDERATIONS IN ANAESTHESIA. By CHARLES L. BURSTEIN, M.D. 2nd ed., Toronto: Macmillan Company of Canada. $5.50.

In little over 200 pages, Dr. Burstein has collected a considerable volume of "physiopharmacological" information (to utilize Dr. Burstein's own adjective). Worthy of special mention are the innumerable references, which include articles published as recently as 1954.

This is essentially a book for the graduate who has had some experience in anaesthesia since, in the opinion of the reviewer, such a background is necessary to comprehend the theoretical and experimental facts relating to the fundamentals of modern anaesthesia which form the main content of the book.

Little is mentioned of techniques of anaesthesia and it seems unfortunate that Dr. Burstein should have chosen the controversial technique of controlled hypotension on which to dogmatize. While the majority of the subject-matter is extremely well presented and above any criticism, mention might be made of a few points:

(a) Dr. Burstein states, on page 47, that "arterial hypotension reduces the vascular supply to the tissue cells and cellular asphyxia is one of the detrimental results." One may feel that this requires to be qualified in the light of experience with controlled hypotension.

(b) Many anaesthetists will not agree with the routine preoperative use of procaine amide, as discussed on page 115.

(c) A discussion of methods of obtaining induced apnoea might have included the use of relaxants.

(d) Dr. Burstein's views on overdosage of relaxants and the treatment thereof will not coincide with those of most anaesthetists in Canada and Great Britain.

Having recorded the above few points, one must reiterate that this is a very worth-while little volume.

H. B. F.

CANADIAN ANAESTHETISTS' SOCIETY, NEW MEMBERS

THE following new members were approved by the Annual General Meeting of the Society at Toronto on June 22, 1955.

British Columbia

1. Dr. Hugh Herbert MacCartney (M.E.), 4336 West 10th Ave., Vancouver
2. Dr. James Blair Fulton (M.E.), 2315 West 18th Ave., Vancouver
3. Dr. James Alexander Gibson (M.E.), Shaughnessy Hosp., Vancouver
4. Dr. Peter William Hudson (M.E.), 4094 West 33rd Ave., Vancouver
5. Dr. Violet A. Larsen (M.E.), Vancouver Gen. Hosp., Vancouver
6. Dr. Evan Arthur Lloyd (M.E.), Vancouver Gen. Hosp., Vancouver
7. Dr. Elsie Ritch (M.E.), 3779 Blenheim St., Vancouver
8. Dr. Benjamin Reid Townsley (O.M.), 4132 Virginia Cres., N. Vancouver
9. Dr. John Michio Yoshioka (M.E.), 456 West 20th Ave., Vancouver
10. Dr. Thomas John O'Neil (M.E.), 2165 Abbott, Kelowna
11. Dr. Kenneth Gibbons (O.M.), 405 Hendryx St., Nelson

Alberta

12. Dr. George C. Clark (O.M.), 1705, 4th St. S.W., Calgary
13. Dr. Sheila Margaret Murphy (O.M.), University Hosp., Edmonton

Saskatchewan

14. Dr. Davina M. Cowan (O.M.), 1220 Colony St., Saskatoon
15. Dr. James Francis Cumming (O.M.), 304 Birks Bldg., Saskatoon
16. Dr. Allen B. Dobkin (O.M.), University Hosp., Saskatoon
17. Dr. Albert Hudec (O.M.), 606 Medical & Dental Bldg., Regina
18. Dr. Christopher J. Kilduff (M.E.), University Hosp., Saskatoon
19. Dr. Z. T. Kubinski (Cert), 1153 Redland Ave., Moose Jaw
20. Dr. Anthony Paul Melgrave (M.E.), University Hosp., Saskatoon

Manitoba

21. Dr. Patrick Martin McGarry (Cert), Children's Hosp., Winnipeg
22. Dr. Margaret Loewen (M.E.), 591 Alverstone St., Winnipeg
23. Dr. Thomas Joseph McCaughey (M.E.), Winnipeg Gen. Hosp., Winnipeg
24. Dr. Christopher Wolkenstein (M.E.), Winnipeg Gen. Hosp., Winnipeg
25. Dr. Marcia Wood (O.M.), 711 Brock St., Winnipeg
26. Dr. Wasyl Zaycew (O.M.), Manitoba Sanatorium, Nimette

Ontario

27. Dr. Michael Campbell (M.E.), 75 Dewson St., Toronto
28. Dr. William Salem Caldwell (O.M.), 9 Main St. S., Brampton
29. Dr. John Wesley Dales (O.M.), 106 Talbot St. W., Leamington
30. Dr. Joseph William Fyfe (M.E.), Hamilton Gen. Hosp., Hamilton
31. Dr. Thomas Hanley (M.E.), 130 Balmoral Ave., Toronto

32. Dr. Ian S. H. Harper (M.E.), Hôtel Dieu Hosp., Kingston
33. Dr. Hugh J. Johnston (M.E.), Apt. 208, Ct. 3, 415 Lakeshore Rd., Toronto
34. Dr. James Gordon Murray (M.E.), 466 Holland Ave., Ottawa
35. Dr. John Graham Robinson (M.E.), 317 High Park Ave., Toronto
36. Dr. Charles P. Crompton (O.M.), 71 Valecrest Dr., Toronto
37. Dr. Helen Gordon (M.E.), 63 Charles St. W., Toronto
38. Dr. E. S. Russell (M.E.), 86 McDonnell St., Kingston
39. Dr. Henry Jack Shykoff (O.M.), 2879A St. Clair Ave. E., Toronto
40. Dr. Natalie M. Staron (O.M.), 58 Greenbrook Dr., Toronto
41. Dr. Harold Cameron (Cert), 489 Carlton St., St. Catharines
42. Dr. H. Barrie Fairley (Cert), 516 Medical Arts Bldg., Toronto
43. Dr. J. E. Higgins (O.M.), 2432 Thorold Rd., Niagara Falls
44. Dr. Wolfgang E. Spoerel (M.E.), 871 Colborne St., London
45. Dr. P. Arcade Perrier (O.M.), 33½ Main East, Hawkesbury
46. Dr. Helen M. Rossiter (Cert), 504 Colborne St., London
47. Dr. John S. Packham (O.M.), 325 Victoria Ave., Chatham
48. Dr. Ming Yao (O.M.), 28 Glendale Ave., Ottawa

Quebec

49. Dr. Adolphe Byk (M.E.), 109 Pine Ave., Montreal
50. Dr. Simon Gervais (M.E.), 2113 est Jean-Talone, Montreal
51. Dr. Lionel Jacques Leduc (Cert), 6645 Molson, Montreal
52. Dr. David John Power (Cert), 5640 Gatineau Ave., Montreal
53. Dr. Jean-Maurice Bergeron (M.E.), 5203, 2nd Ave., Rosemont, Montreal
54. Dr. George Frederick Brindle (M.E.), 5309 Place Lucy, Montreal
55. Dr. Albert Cossette (M.E.), Hôpital Notre-Dame, Montreal
56. Dr. Harold Thomas Davenport (Cert), Montreal Gen. Hosp., Montreal
57. Dr. Rosario Denis (M.E.), 2757 Laurier E., Montreal
58. Dr. Francois Lafleur (M.E.), 222 Prince Arthur St., St. Lambert
59. Dr. Joseph Lafortune (Cert), 422 Manseau Blvd., Joliette
60. Dr. Patrick R. Laughrea (Cert), 794 Labbe Blvd., Thetford Mines
61. Dr. Francois Moreau (M.E.), 3801 Barclay, Montreal
62. Dr. John Leys Oulton (M.E.), 204 Elm Ave., St. Lambert
63. Dr. Jean Phaneuf (M.E.), 24 des Erables, St. Hilaire, Co. Rouville
64. Dr. Ivan Rado (M.E.), 3221 Forest Hill, Montreal
65. Dr. N. B. Urie (M.E.), 1375 Sherwood Crescent, Montreal
66. Dr. Gerard Mignault (Cert), 8368 Château Briand, Montreal
67. Dr. W. A. Wielhorski (Cert), Maisonneuve Hospital, Montreal

Nova Scotia

68. Dr. Stanislaw B. Donigiewicz (O.M.), P.O. Box 638, Antigonish

Newfoundland

69. Dr. Abraham Levitz (Cert), 140 Elizabeth Ave., St. John's
70. Dr. Thomas G. Stentaford (Cert), 11 Winter Ave., St. John's

Foreign

71. Dr. Deidre M. Gillies (M.E.), Huron Rd. Hospital, Cleveland, Ohio, U.S.A.
72. Dr. Lionel Glassman (Cert), 6002 Wallis Ave., Baltimore 15, Maryland, U.S.A.
73. Dr. Michael Keeri-Szanto (M.E.), 2024 Commonwealth Ave., St. Paul, Minn., U.S.A.
74. Dr. Frank Moya (M.E.), United States Naval Hospital, St. Albans 25, New York, U.S.A.
75. Dr. Lev Spinadel (Cert), Praha 1, Celetna 23, Czechoslovakia

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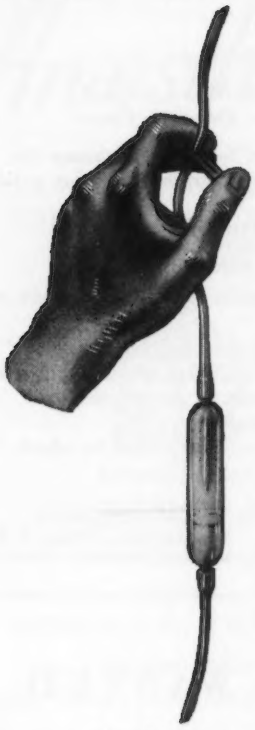

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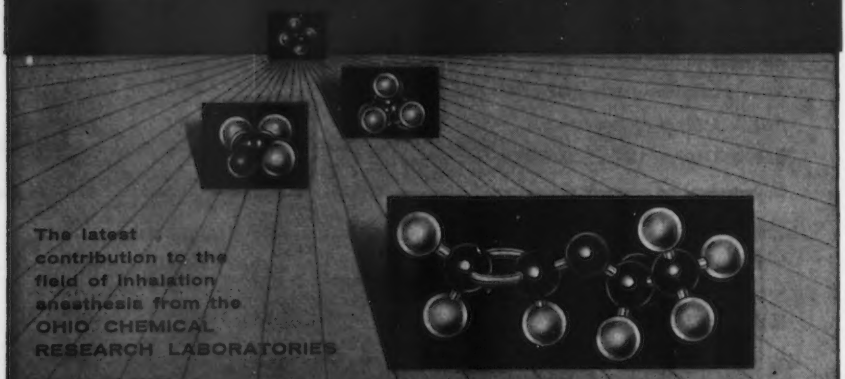

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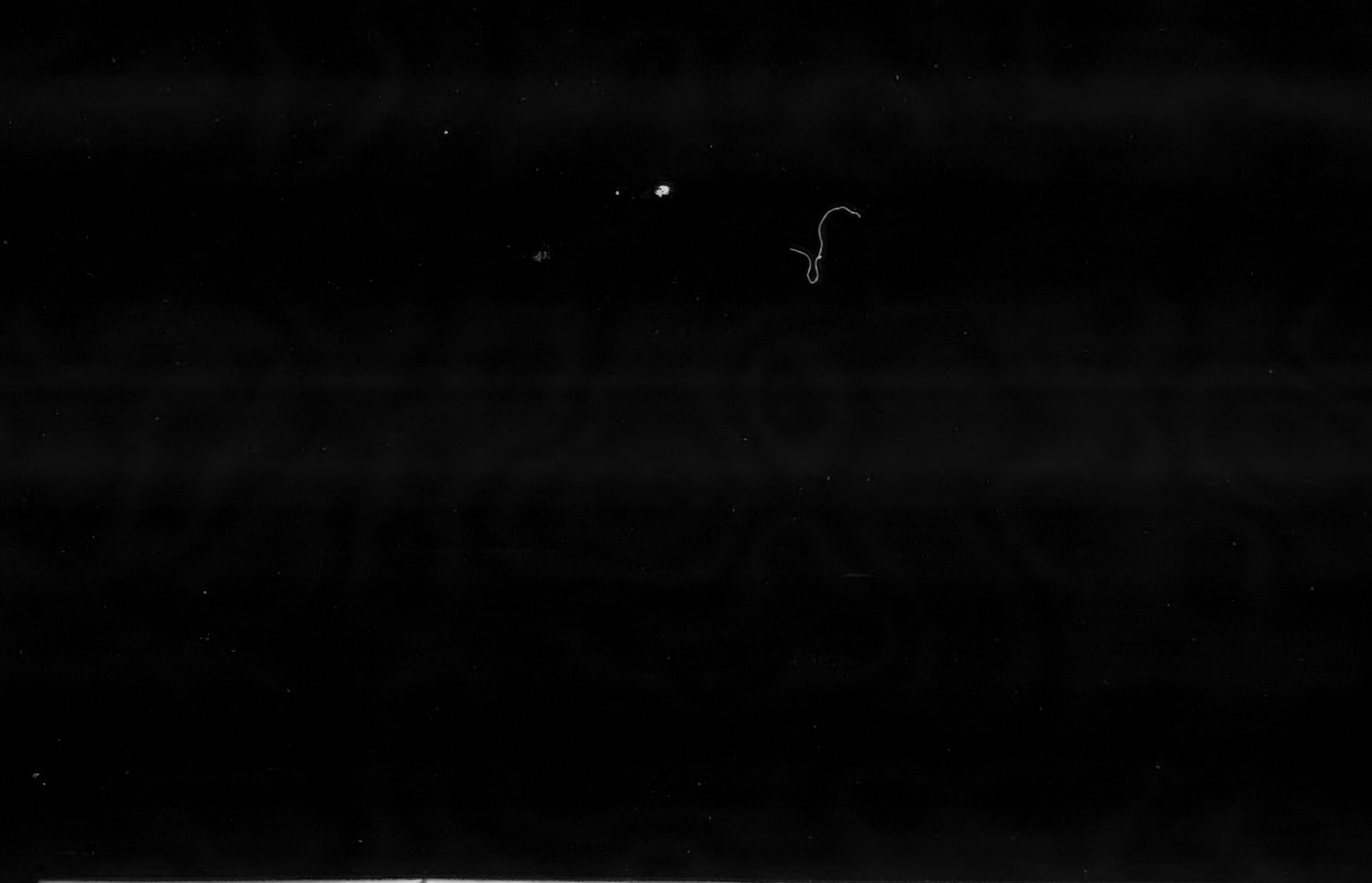

THE CANADIAN ANAESTHETISTS' SOCIETY JOURNAL

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The Canadian Anaesthetists' Society Journal is published quarterly by the Canadian Anaesthetists' Society Inc. Original articles are accepted for publication on the understanding that they are contributed exclusively to this journal and become the property of the Canadian Anaesthetists' Society. Articles are subject to such alteration as the Editor in his absolute discretion may deem necessary, but no major alterations will be made without consent of the Author.

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Articles should be typewritten in double space on one side of the paper only. Pages must be serially numbered, and each page should carry at its head the name of the author and the title of the article in full or in an appropriate abbreviation. The article should be concluded by a summary which will be intelligible without reference to the main text. All articles should be accompanied by a résumé presenting the important features in short form, for translation into the French language. French-speaking authors should provide this résumé in the French language.

References to the literature should be clearly indicated in the text by arabic numerals in brackets, thus (4). They should be set out in numerical order at the end of the article, typed in double space, as follows:

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